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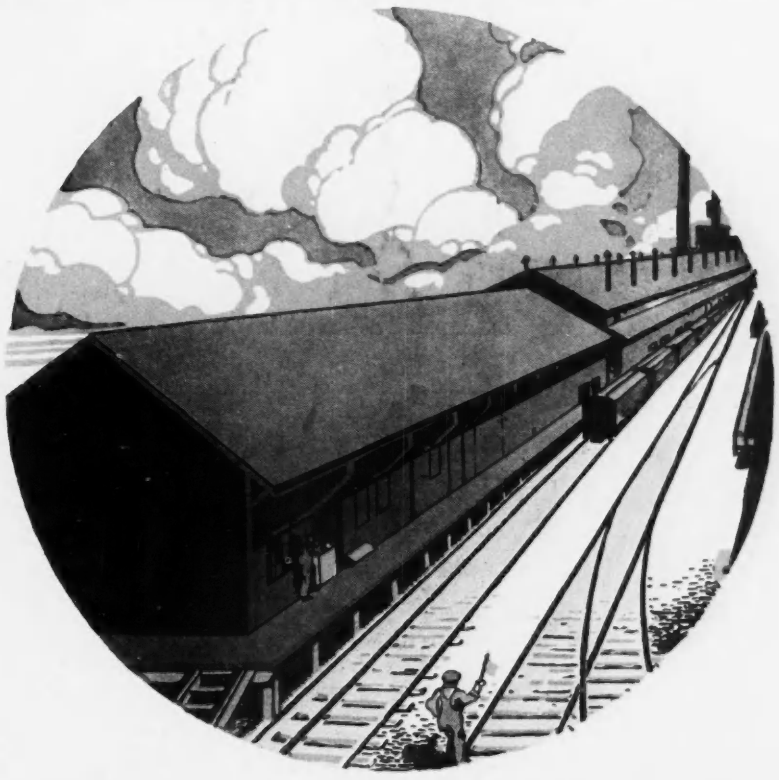
# Engineering News

Volume 77, No. 12
Issued Every Thursday
McGraw-Hill Publishing Co., Inc.

NEW YORK, MARCH 22, 1917

Price, 15 Cents
Contents, First Page
Advertising Index, Last Page



## *Only a Week's Interruption by Fire!*

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BRIEFLY THIS IS THE STORY: On Wednesday, November 8th, the East St. Louis Cotton Oil Co. wired that their baled shavings plant had been burned. Our superintendent left that night. On Monday the site was cleared up and 12 carloads of lumber had arrived. On Wednesday over 12,000 square feet of flooring was down, and on Thursday the buildings were sufficiently advanced for work to be resumed. This speed was appreciated by our clients as the rebuilt units are necessary to the operation of the plant.

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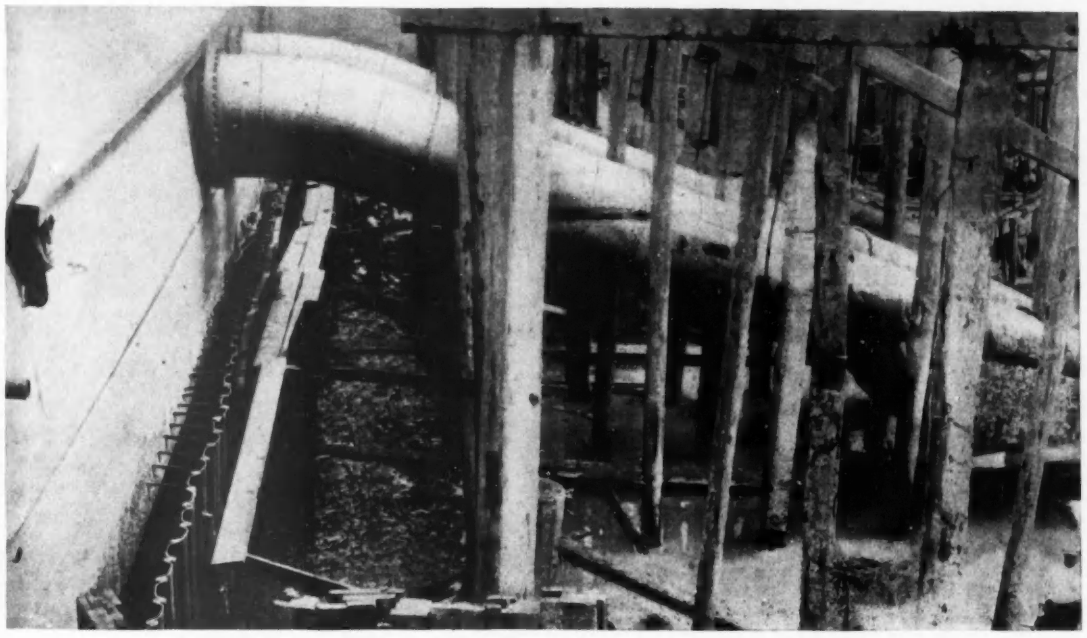

# The Lackawanna Sheet Piling Cut-Off Wall Driven to Strengthen the Wall of a Reclamation District Pumping Plant.

The machinery of the 300,000 gallon-per-minute pumping plant of Reclamation District, No. 108, San Francisco, Cal., is housed in a heavy reinforced concrete building founded on bearing piles. After the second year of operation, a reinforced concrete sump to prevent cave-in near the five six-foot suction pipes (three shown above) and a permanent cut-off wall connected to the concrete building were considered desirable and a contract for the work was awarded to Haviland & Tibbetts, Engineers, San Francisco.

Lackawanna Arched-Web Sheet Piling was chosen for the cut-off wall because of its watertightness, exceptional transverse and tensional strength, and because it could be driven close to and joined to the building.

The sheet piling had to penetrate 8 to 10 feet of quicksand and 10 to 12 feet into underlying hardpan, yet, as may be observed, the line of tops is even and shows no battering. Wooden sheeting 6, 8 and 10 inches in thickness driven near this wall came to refusal with 8 to 10 feet less penetration.

In driving, a follower was used in connection with the pile-driver which was at least 15 feet above tops of the steel sheet piling sections. The suction pipes were unbolted at the flanges immediately outside the building and withdrawn to leave a gap of about 12 inches.

The tops of the sheet piling sections were attached to the building by $1\frac{1}{4}$-in. wedge bolts set in stone in holes drilled 3 feet into the concrete. The joints were then rendered watertight by cement mortar and the tops of the piling sections encased in the reinforced concrete walls of the pumping sump.

This is a very practical form of protection for walls that show signs of weakness or may be weakened by adjoining excavation.

Our book, "Lackawanna Steel Sheet Piling," explains numerous cut-off wall constructions and our Sheet Piling Engineers will suggest designs for difficult conditions.

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Engineering News

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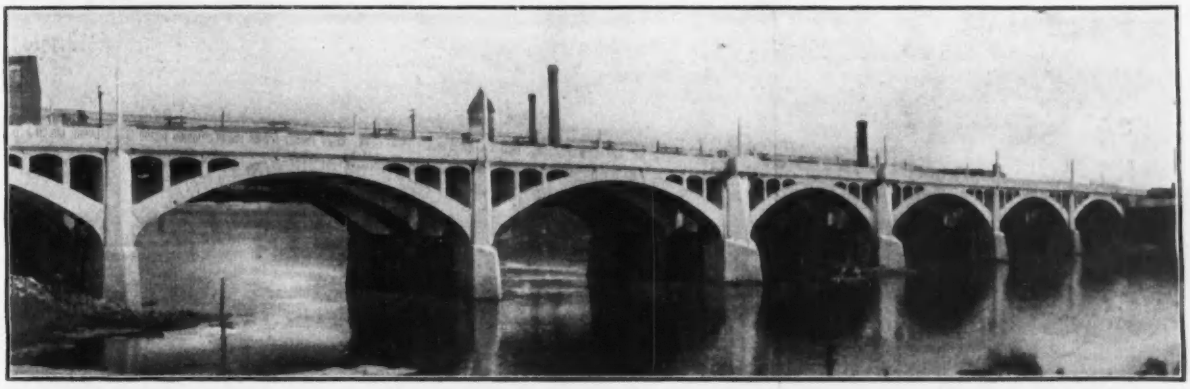
# Pleasing Architectural Appearance of the Central Bridge at Lawrence

By E. K. Cortright*

Special efforts have been made in the design and construction of the Central bridge, Lawrence, Mass., to secure a pleasing æsthetic appearance. This reinforced-concrete highway structure, 80 ft. wide and approximately 1700 ft. long, crossing the Merrimack River, furnishes access directly to the center of the business district. The roadway, paved with granite blocks, is 56 ft. wide between curbs, with provision for double-track street-railway traffic.

The approaches at either end consist of earth-filled retaining walls of the counterfort type and 44-ft. span segmental arches directly supporting the floor slab. The seven river spans are 116 ft. center to center of piers, with a rise of 20½ ft. Each of these spans has three arch ribs supporting bench walls that provide bearing for the floor system of transverse beams and floor slab. As the approach work presents a broad plain-surface appearance, it brings into pleasing contrast the light open-spandrel treatment of the main arches. Massive shore abutment piers, hollow above the ground, serve to accentuate the river spans. At the bridge floor provision has been made for future construction of pylons to emphasize this effect further.



THE NEW CENTRAL BRIDGE, LAWRENCE, MASS., A STRUCTURE DESIGNED FOR PLEASING APPEARANCE

In the original design the six river piers, 9 ft. wide at the springing line, were to be built on compact river gravel 14 ft. below normal water. Legislation subsequent to the award of the contract necessitated provision for possible future navigation. Consequently only four river piers were completed as designed, the two middle piers being redesigned to act as abutments for a future bascule span. Permission was obtained from the Federal authorities to construct a concrete span over the proposed channel, with the understanding that the city will remove the concrete span and provide an operating bascule draw upon demand of the War Department. Compressed-air caissons were used in sinking these bascule abutment piers to bedrock, 25 to 50 ft. below the river bed.

The striking treatment of the massive bascule piers above the springing line deserves attention, as its use in this country has been very limited. A battered face truncates what otherwise would be the triangular prism at the pier nosing, the shape of the imaginary piece removed being that of an inverted triangular pyramid. The resulting effect is to lighten greatly the appearance of these piers and to remove what otherwise would be a decided tendency for them to appear bulky and topheavy.

The intrados of the main arches is three-centered for the sake of economy, but approximates an ellipse for its pleasing appearance. These arch rings were poured in a series of blocks and keys; to overcome the unsightly appearance of the joints, all voussoir faces are divided by means of scoring strips into a series of voussoir blocks. These blocks vary proportionately in depth and width from the crown to the haunches.

The balustrade was designed with special attention to aid the appearance of lightness of the bridge in side elevation. The predominance of vertical lines in the balustrade secures this effect. An uneven number of panels was used to avoid the heavy appearance occasioned by a post directly over the key of the arch. The balustrade concrete was mixed in 1:2:3 proportions with granite dust and chips for aggregate. All panels are bushhammered with a pleasing result.

The Central bridge was built for the City of Lawrence by Ryan & Keon, of Boston. B. H. Davis is Consulting Engineer.

*Resident Engineer, Central Bridge, Lawrence, Mass.

# Sinking Extensive Caisson Foundations for a St. Louis Hotel

Concrete piers built in wells or caissons sunk by the pneumatic process form the foundations for the new Statler Hotel at St. Louis, Mo., and rapid progress was a feature of this foundation work. The building is to be 150 x 130 ft., with the longer front on 9th St. and the shorter sides on Washington Ave. and St. Charles St. It will be 18 stories high, with basement and sub-basement. The architects are George B. Post & Sons, of New York, and Mauran, Russell & Crowell, of St. Louis. The contract for the foundation work was taken jointly by the Fruin-Colnon Contracting Co., of St. Louis, and the Missouri Valley Bridge & Iron Co., of Leavenworth, Kansas.

The foundations consist of 50 concrete piers, 5 ft. 6 in. to 8 ft. 3 in. in diameter, sunk through water-bearing sand to bedrock (white limestone) at a depth of about 55 ft. below the sidewalk level (or 27 ft. below the floor of the open excavation). Fig. 1 shows the work in progress in this excavation, at about the sub-basement level.

The caissons are built of vertical planks 2¾ x 5½ in., in 14-ft. lengths, with inside and outside girts or ring braces of angles 3 x 3 x ¼ in. The cutting edge is a ¼-in. plate 24 in. high, with a plate 6 x ⅜ in. and angle 3 x 3 x ¼ in. riveted inside the bottom. At the plane of the top of this angle is a course of interior bracing consisting of two sets of steel plates 4 x ¼ in., put together like the segments of arch or tunnel centering. This construction is shown in Fig. 2.

The 5-ft. working chamber above the cutting edge was of concrete, with a wall 6 in. thick. Above this was the steel shaft, 3 ft. 6 in. in diameter, supporting the air lock at the top. The shaft was in 8-ft. lengths, each composed of four vertical segments having interior angles, with wooden key strips 2¼x4 in. bolted between them. By removing the bolts and timbers the shaft sections could be collapsed and removed. As the working chamber sank, the outside of the wall was sheathed and the steel shaft extended, while concrete was filled into the annular space between this shaft and the sheeting.

A pressure of 10 to 15 lb. was carried in sinking the caissons, which necessitated weighting them with pig iron, as shown in Fig. 1. Excavated material was taken out and concrete taken in by means of buckets of 9-cu.ft. capacity. When rock was reached, holes were drilled to a depth of 6 ft. to insure that the work was in solid rock, after which the working chamber was filled with concrete. The steel shaft was collapsed by removing the bolted wood keys (Fig. 2), and the space within the concrete shaft lining was then filled to the top with concrete.

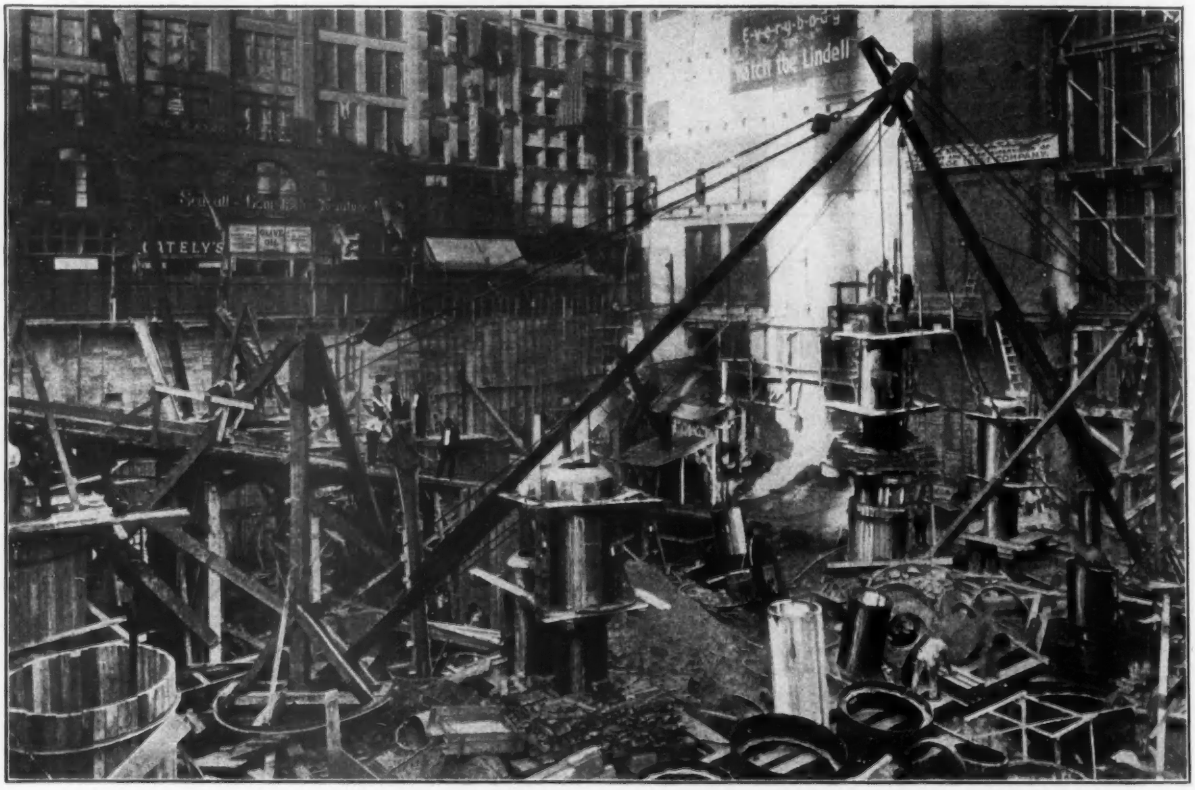



FIG. 1. SINKING CAISSONS FOR FOUNDATION PIERS FOR THE STATLER HOTEL AT ST. LOUIS, MO.
Note the pig-iron loading on some of the caissons. Also the height of concrete retaining wall. At the left is the cable incline for wagons and in the foreground are some of the cutting-edge sections for caissons

As the site has three street fronts, the only adjacent buildings are at the rear; and here a party wall of the seven-story Lindell Building has to be carried. The site was excavated to a depth of about 28 ft. below the sidewalk level by means of revolving steam shovels. The material was loaded into horse-drawn dump wagons, the teams being assisted up the steep driveway to the street by means of a steam hoist with cable hitched to a dummy or car pusher (Fig. 1). The compressor plant comprised a steam-driven Ingersoll air compressor of

900-cu.ft. capacity and a belted Sullivan compressor of 1000-cu.ft. capacity, the two machines being worked alternately. The caissons were served by three stiff-leg derricks with 50-ft. booms.

Cantilever girders were required to carry the columns at many points. Most of the outer piers have enlarged

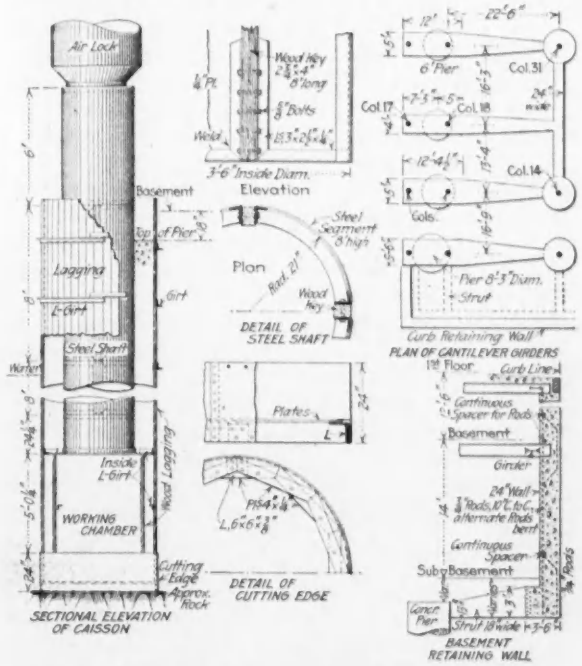



FIG. 2. SHAFT FOR FOUNDATION PIERS AND CANTILEVER FOOTINGS

cantilever caps serving as footings for two columns, spaced sometimes at equal and sometimes at unequal distances from the center line of the pier (Fig. 2). As piers could not be sunk under the party wall, the wall columns here are seated on the ends of reinforced-concrete cantilever girders, each carried by a pair of the concrete piers.

A 24-in. reinforced-concrete retaining wall extends around three sides of the lot, at the curb line, and owing

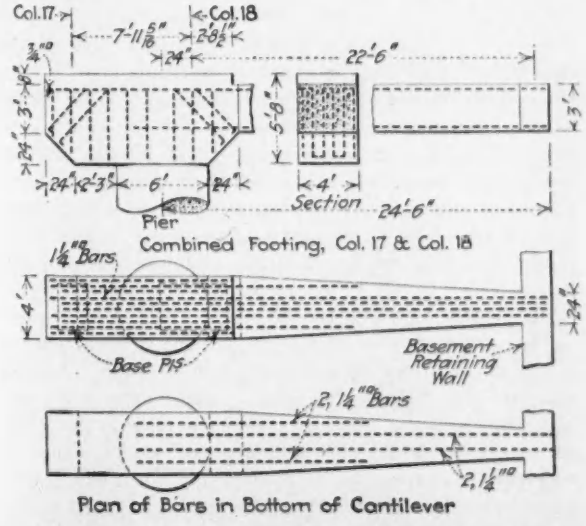



FIG. 3. DETAILS OF CANTILEVER GIRDERS TO CARRY PARTY-WALL COLUMNS

to its height this had to be braced during construction. Its bottom is braced against the heads of the foundation piers by concrete struts (Fig. 2), while as soon as the steel structural work was commenced, the top of the wall was braced against the steel columns by struts and girders carrying the basement floor and first floor.

Rapidity of progress was one of the essentials of the contract. About six caissons were under way at a time, and the entire number (50) were sunk and concreted in about 50 days. The work included 17,000 cu.yd. of excavation (including old rock foundations that required blasting) and 1600 yd. of concrete in walls and piers. All this was completed in 110 calendar days and nights, which was 10 days ahead of contract time, in spite of 35 days of excessively hot weather.

## Knocking Down 120-Ton Electric Locomotives for Export

Three 120-ton electric locomotives had to be shipped from the Erie Works of the General Electric Co. to the Bethlehem-Chile Iron Mines Co., at Tofo, Chile, but the lifting capacities of ship and dock cranes for loading on board vessels, and for removing on arrival, were insufficient. It was therefore necessary to take the locomotives apart, to classify the parts according to size and weight, and to box them into easily handled shipping cases.

The locomotives were erected at the Erie Works, put on test tracks and run under operating conditions to bring out defects of material or workmanship. These machines follow the lines of a half-unit of the Chicago, Milwaukee & St. Paul type, are intended for use on 2400-volt direct-current circuits, and have regenerative braking equipment.

After test, the parts were all marked and ticketed in systematic order, so that the locomotive could be reassembled exactly as it stood under test. First, the pantograph trolleys were taken off and then the hatch covers of the roof, exposing the control and regenerative braking equipment. Through the openings thus made, the smaller parts were taken off—including the motor-generator set, air compressor and the control-equipment supports and contactors.

While these parts were being boxed, the roof, weighing 5 tons, was removed. (Roof and sides had been assembled with bolts and nuts to facilitate dismantling.) The roof was packed on the locomotive platform after the equipment had been stripped from it. All the electrical connections were opened up after the removal of the roof, and the various panels, contactor compartments and other apparatus were removed. Then the sides and end frames were taken down.

The platform proper was the heaviest part of the shipment, weighing 16½ tons; with the roof and necessary boxing for shipment, this package weighed 23 tons, being the heaviest single article.

The motors were removed from the trucks, the brake rigging and accessories were disassembled, the trucks were separated, and the axles were removed. When thus completely prepared for rail shipment, one locomotive occupied three box-cars and five flat-cars. With the exception of the one 23-ton case, the entire shipment was stowed in the hold of a South American freighter (the "Celia," owned by W. R. Grace & Co.). The big case was lashed on deck.

# Art Gallery Built on a 200-Ft. Bridge

The new extension of the Chicago Art Institute presents the unusual feature of a building that is structurally a two-span bridge, as it spans the depressed tracks of the Illinois Central R.R. and is carried by through trusses concealed within the side walls of the building. One end of the new structure connects with the main building on Michigan Ave., and the other end has its entrance in Grant Park. It is a two-story building about 230 ft. long and 58 ft. wide. The width of the railway right-of-way is 200 ft. between the retaining walls. The arrangement and general structural design are shown in Fig. 1.

The main structural part of the building consists of two steel through-truss spans 101 ft. 3½ in. long, supported on end walls and a central pier. These trusses are 27 ft. 3 in. c. to c. of chords and are spaced laterally 53 ft. 7 in. c. to c. Upon their top chords are seated the transverse roof trusses. The building was intended originally to have but one floor, with a clear height of about 30 ft., this to be used as a statuary room. Its floor was designed for a live-load of 300 lb. per sq.ft. Later, it was decided to use it as a picture gallery, with two floors, allowing a load of 100 lb. per sq.ft. on each floor.

The truss design is peculiar in that the end panels at the center pier are half the length of the other panels; that is, each truss has five panels of 18 ft. 5 in. and one end panel of 9 ft. 2½ in. The bottom chords, however, are spliced at their abutting ends. One set of gusset plates serves for the connections of the two steeply inclined end posts and serves also to splice the chords. This is shown in the detail drawing, Fig. 2.

The bottom chord is a heavy box girder 48 in. deep, having two webs 15 in. apart, with vertical diaphragms between them. Each web has from two to four plates, with outside flange angles from end to end and inside flange angles in the middle panels. Top cover plates are fitted between the posts, and lacing bars connect the bottom flanges.

The end posts and top chords are of generally similar design, but with 24-in. webs and with top and bottom lacing and batten plates. The two adjacent top chords are connected at the hips by a light longitudinal member that forms part of the auxiliary framing to carry the interior walls, etc. The posts are of H-section. They are riveted between large connection plates and extend through and above the top chords, as attachments for the roof trusses. The diagonal members are pairs of rolled or built-up channels, with top and bottom lacing.

In the first floor the floor-beams are pairs of 30-in. plate girders spaced 24 in. c. to c. The end floor-beams, however, are single 60-in. girders. Between these are framed the stringers, which are mainly 15-in. I-beams spaced 5 ft. 9 in. c. to c. On this steel framing is a 4½-in. reinforced-concrete slab deck and a 3-in. concrete floor. The stringers and girders are incased in concrete. A 3-in. shield of asbestos blocks will be placed beneath the level of the floor-beams, being carried by hangers attached to the steel frame.

The second floor has transverse 24-in. plate girders and 24-in. I-beams framed between the truss posts. The depth of truss did not permit second-story floor-beams of sufficient size for the 53-ft. span, and as columns in the first floor were not permissible, it was decided to carry the middle of each floor-beam by a hanger from the roof truss above it, as noted later. The stringers are 24-in. I-beams with 10-in. hollow-tile flat-arch floor construction covered with a concrete floor. Beneath this is a ceiling of metal lath and plaster, carried by hangers attached to the floor framing.

The roof was designed originally with light trusses, simply strong enough to carry the roof framing and glass covering. When it was decided to carry part of the second-floor load from the roof, it was necessary to reinforce these trusses materially. This was done by means of reinforcing trusses, as shown in Fig. 3. Each consists of inclined chords beneath those of the original truss, with their ends connected by a horizontal chord. Each of these members consists of a pair of 15-in. channels connected by batten plates, the original trusses being sandwiched between the channels. The hangers are flat bars attached to connection plates at both chords and carrying gussets to which the floor-beams are riveted.

The outer ends of the main trusses are carried by H-section columns embedded in the concrete retaining walls on the right-of-way lines. The columns of each pair are connected near the top by a plate-girder strut seated on brackets, but there are no bottom struts or diagonals to connect the columns and form a bent. The inner ends of the trusses are seated upon the columns of a steel bent embedded in a concrete pier between the tracks. The columns are of H-section and very similar to those

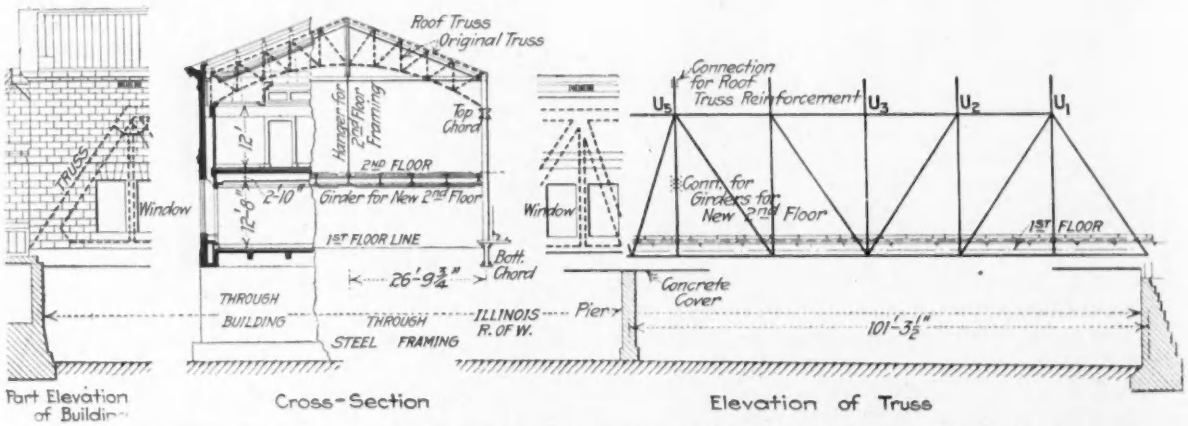



FIG. 1. EXTENSION OF THE CHICAGO ART INSTITUTE SPANNING RAILWAY RIGHT-OF-WAY 200 FT. WIDE

at the outer ends. They are 20 ft. 3 in. long, $20\frac{1}{4}$x$29\frac{3}{8}$ in. in section and are of very heavy construction. Each side web is composed of three 20-in. plates and two outside flange angles, with an 8-in. outside plate between the edges of the angles. The transverse web is composed from the roof, which is covered entirely with glass. The lower floor has windows, but they are not made to open. An outside gangway is provided for the use of the cleaners.

A curious feature of the erection work was that the

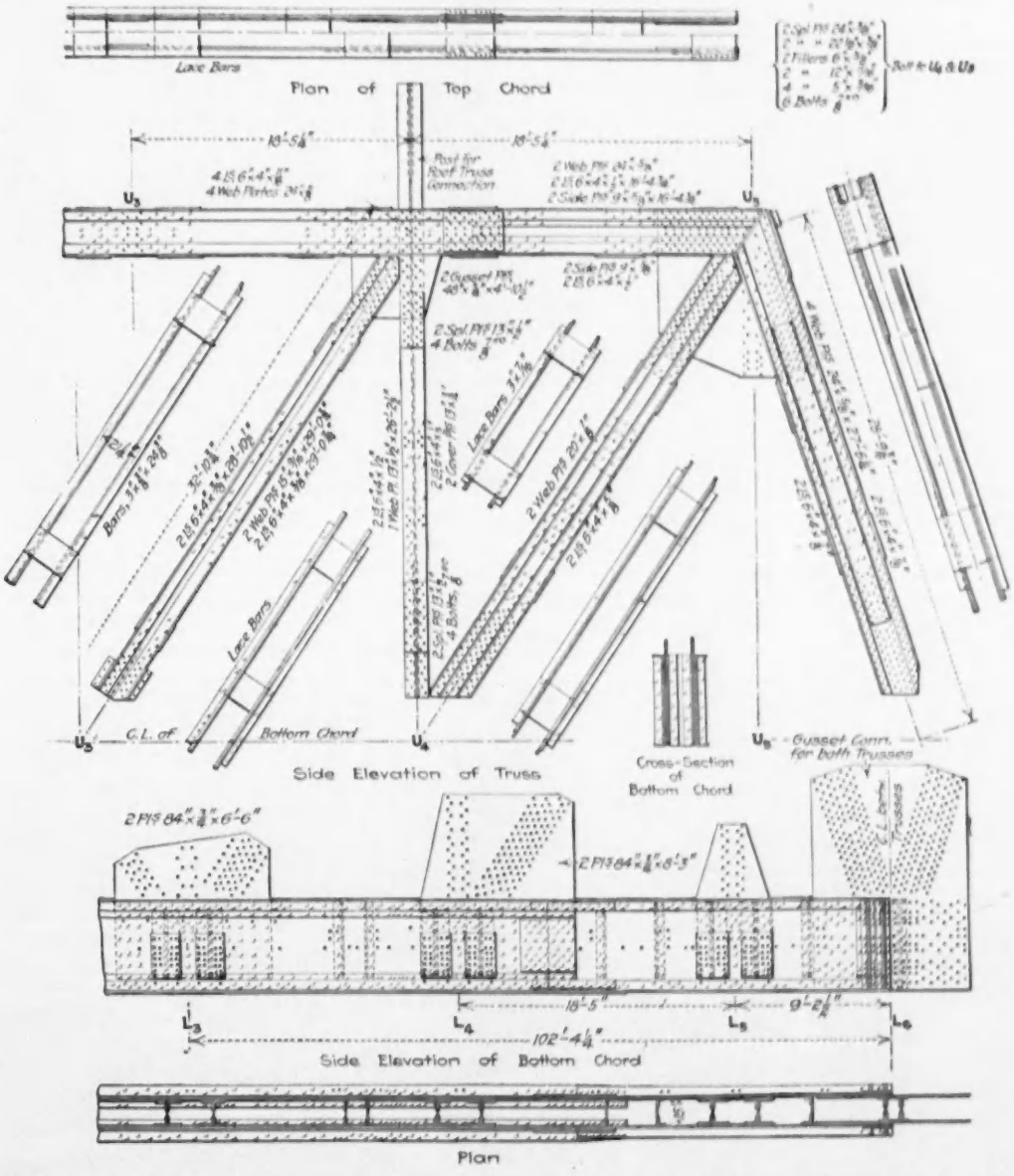



FIG. 2. DETAILS OF 100-FT. MAIN TRUSS CARRYING ART GALLERY FOR CHICAGO ART INSTITUTE

of a single 12-in. plate with four connection angles, and the side webs are connected by batten plates. These columns are connected by top and bottom struts and a pair of diagonals.

The original intention was to have all the steelwork embedded in concrete. As constructed, however, only the bottom chords and first-floor framing are so covered. The truss members and upper-floor framing are incased in tile fireproofing. The roof trusses, on the other hand, are left exposed.

The exterior walls are of stone veneer, anchored to steel girts between the truss members. The inner walls are of tile The upper floor has no windows, but is lighted

bottom chords of the trusses remained in place for two or three years (as simple beams of 100-ft. length) before the truss members were placed. The chords had been made heavy enough to stand in this way, in order to avoid the necessity of falsework between tracks during the erection.

The architects are Coolidge & Hodgden. The truss design was made originally by the Illinois Central R.R. engineers, but the revised form of the structural design was made for the architects by Julius Floto, consulting engineer.

The steel was fabricated by the American Bridge Co. and erected by the Oscar Daniels Co.

# Deep Foundations of Metropolis Bridge; Built Under 51 Lb. of Air

By W. McCready*

The construction of the Paducah & Illinois R.R. Co.'s bridge over the Ohio River at Metropolis, Ill., offers a number of novel and interesting features, among these being the extensive use of silicon and nickel steel in the superstructure, the construction of the longest simple-truss span in the world and the unusually large and deep foundations.

The Ohio River at this point is about 3000 ft. in width at low water and 7000 ft. at extreme high water, the gage showing a variation of 53 ft. between low- and high-water stages. The underlying soil consists of yellow and blue clay, gumbo and sand, rock being found only at a depth of 240 ft. below low water. It was therefore decided to use spread foundations and land the piers on a stratum of fine white quartz sand that, the soundings showed, lay at a depth of 70 to 90 ft. below low water. (See the strata found in sinking, Fig. 8.)

The total length of the bridge is 5700 ft. The north approach is 1593 ft. long, of deck plate-girder and tower construction with slab-ballasted deck, on pedestal foundations, with the exception of three piers, *A*, *B* and *C*. The river portion, seven truss spans, consists of a 300-ft. span at the north end, four 551-ft. spans, one 720-ft. span and one 246-ft. deck span. The south approach includes 605 ft. of viaduct construction of the same type as the north approach and an 85-ft. fill containing about 1,000,000 cu.yd. of earthwork.

All steel was designed for Cooper's E90 engine loading, with two engines on the near track followed by a train load of 7500 lb. per lin.ft., and on the far track the train load only. In the truss spans all main members except eye-bars are of silicon steel, with an allowable unit-stress of 30,000 lb. per sq.in. All eye-bars and pins are of nickel steel, with allowable tensile unit-stress 35,000 lb. per sq.in. and bearing of 20,000 lb. per sq.in. All other material is medium steel at 20,000 lb. tension and 24,000 lb. tension and compression for wind stress. The total weight of steel in the truss spans and approaches is 17,000 tons.

The construction of the seven river piers was done by contract, and the remainder of the substructure work by company forces.

The pedestals are of round-shaft type, 5 ft. in diameter at the top, side batter ½ in. to the foot, on a 19½-ft. octagonal foundation 3 ft. deep containing four-way reinforcement of ¾-in. corrugated bars at 6-in. centers

*Principal Assistant Engineer, Paducah & Illinois R.R., Metropolis, Ill.

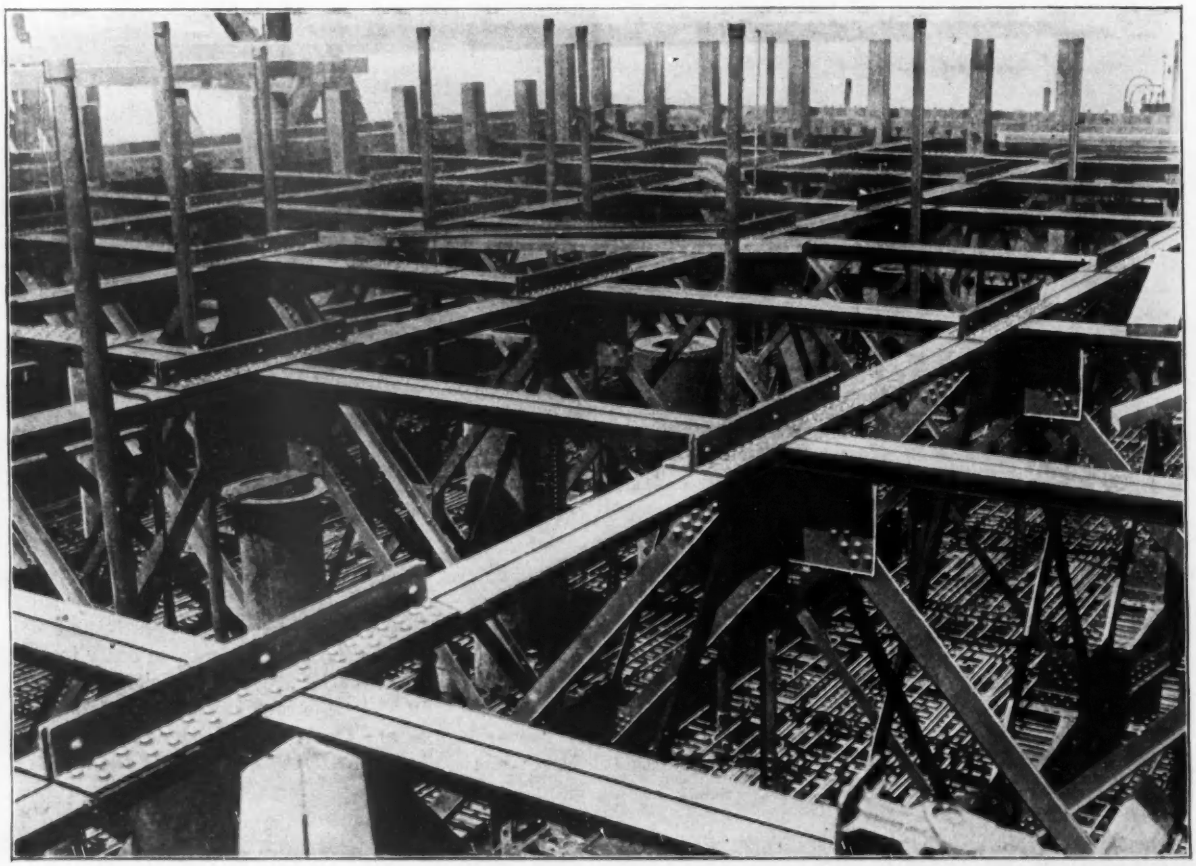


**FIG. 1. STEEL TRUSSES AND BOTTOM REINFORCEMENT IN THE ROOF OF THE WORKING CHAMBER**
Trusses carry the concrete until it has set sufficiently to take load. This keeps load off timber roof of working chamber

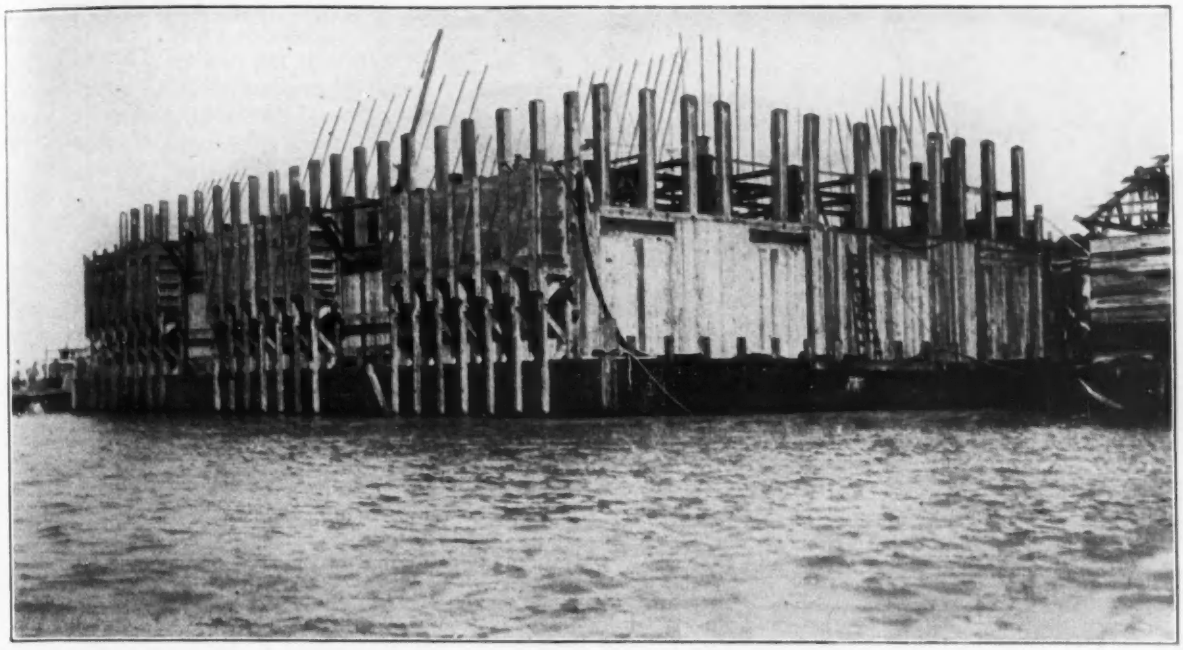


FIG. 2. CAISSON 6 IN THE PONTOON, ABOUT TO BE LAUNCHED

in the bottom. The shafts are reinforced with ¾-in. vertical and ½-in. hoop bars, and the seats with a grid of ¾-in. bars 3 in. on centers.

A construction track was built on the center line of the bridge between the pedestals, and the excavation done with a Browning locomotive crane, using bucket and skip. Practically no sheeting and bracing was required, even in pits 22 ft. deep, as the material gone through was a very stiff clay. A ½-cu.yd. motor-driven mixer mounted on a flat-car, using 2200-volt current from the city power lines, was used on the north approach, and a steam-driven mixer of the same size on the south approach. The motor-driven mixer also poured the 13,400 lin.ft. of concrete piling required and the 445 deck slabs, all made in a special yard near the bridge site.

The pedestal forms, of special design, were furnished by the Blaw Steel Construction Co.

Pedestals 1 to 20 inclusive and piers *A*, *B* and *C* were put down to a very hard cemented gravel. For pedestals 21 to 33 inclusive, 20-ft. concrete piles 14x14-in. section were driven to gravel, using a water jet. Each pedestal contains 22 of these piles. A test pile driven into this gravel required 56,255 blows with a No. 2 Vulcan steam pile hammer to secure a penetration of 15 ft. No sinkage showed under the last 2600 blows.

### The Deep River Piers

Work was started in June, 1914, but owing to war conditions was suspended in September, 1914, and resumed in June, 1915. As the river was then at a low stage, the caisson for pier 1 was built on the ground. Air was turned on, July 27, 1915, and sinking proceeded with no delays, averaging 1.2 ft. per day until landed on a very fine white sand, Sept. 22, 1915, and sealed five days later. The pressure plant for this pier, consisting of three units supplying a maximum of 3600 cu.ft. of free air per minute, was established on shore, about 200 ft. from the pier site.

In sealing, the working chamber was divided into four compartments by bulkheading from the truss timbers to the roof. In this way a section could be poured before setting commenced, the end sections being run first. Concreting was done with the concrete lock on the material shafts. A special barge of fine gravel was used to secure a free-running mixture.

Bearing tests taken with hydraulic jack on the sand in all piers showed a value of over 20 tons per sq.ft. The area of the bearing block was 139.4 sq.in., using as large a block as possible to develop the full capacity of

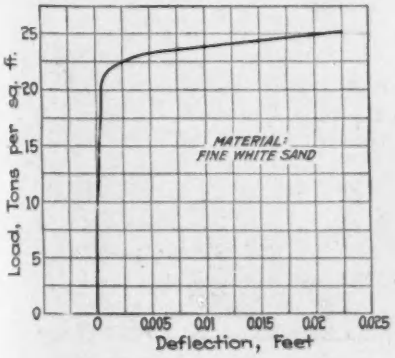



FIG. 3. CURVE FROM SOIL-BEARING TEST AT PIER 1

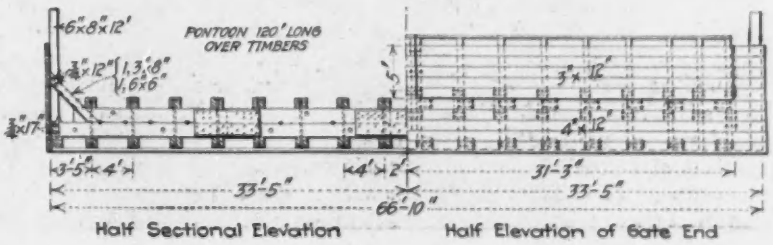



FIG. 4. CROSS-SECTION OF PONTOON FOR FRAMING AND LAUNCHING THE PIER CAISSONS

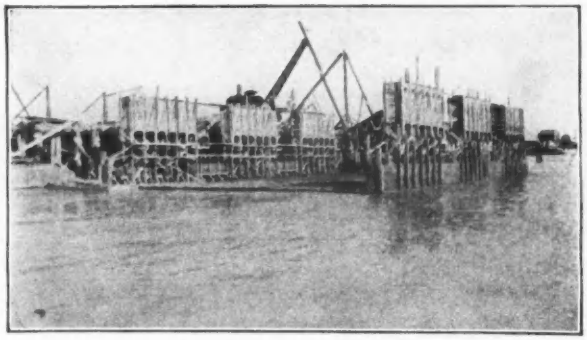


FIG. 5. GATE END OF THE LAUNCHING PONTOON

the jack. Fig. 3 shows a typical curve plotted from one of these tests.

Caisson 7, the next built, was also constructed on shore in position, but a brush and sand mat about 7 ft. thick on the stream side was required, as the bank sloped about 45° at this point. The caisson was built 21 in. off center to allow for drifting. The correctness of this allowance was proved when, in spite of the fact that the caisson was kept over 3 ft. out of level, it came to true position after being sunk 16 ft. No trouble was experienced in holding this position during the remainder of the sinking. The sinking averaged 1.41 ft. per day.

Caisson 6, the next built, was the largest of the seven, being 60½x110½ ft. Caissons 2, 3, 4, 5 and 6 were built in a pontoon 65x120 ft. (Figs. 4 and 5) and floated to position.

An interesting feature of this pontoon was the use of a gate for submerging instead of the usual split design. One end was so constructed that it would float out when the pontoon had obtained a submersion of about 6 ft. Attached water boxes, containing about 75 tons when filled, were used to sink the pontoon clear of the caisson, when it was easily floated out. Fig. 4 shows the pontoon framing.

Considerable delay was experienced at pier 6, due to high water. It was finally landed Mar. 21, 1916, and sealed Mar. 24, 1916.

### High Water Made Greatest Depth of Work 113 Ft.

Piers 2 and 3 were started Dec. 8 and 14, 1915, respectively, and a great deal of difficulty was encountered. High water caused about two months' delay, and there was trouble with scour at No. 3. During the crest of the high water, soundings showed a scour of 16 ft. at the upstream end of the caisson, with a penetration of about 17 ft. Sand bags jetted under the cutting edge and dumped from the surrounding dock finally checked the action.

Caisson 2 was sealed at a depth of 111.5 ft. below water, Apr. 25, 1916. Caissons 4 and 5 followed; and on account of the scour at No. 3 and because clay showed in the bottom, they were sunk about 12 ft. farther than originally intended. No. 4 was sealed at a depth of 113.2

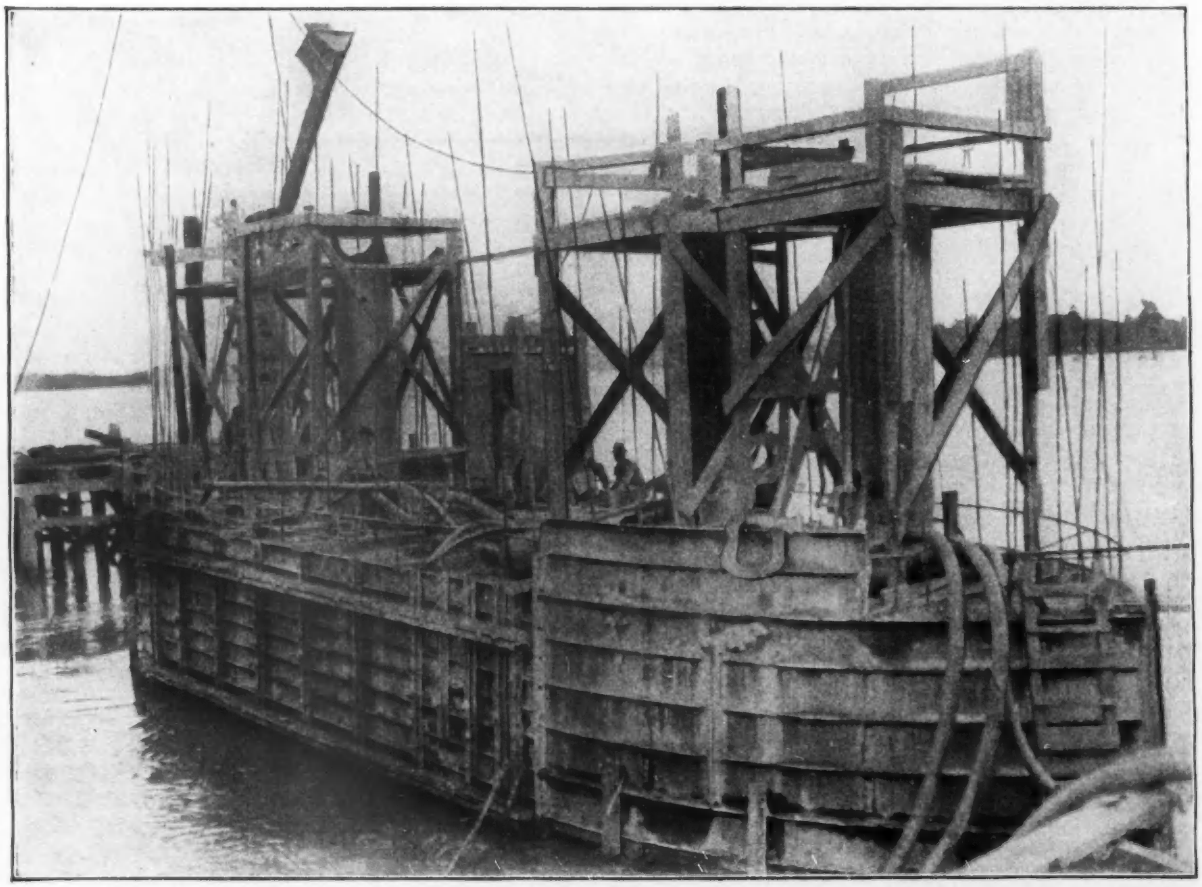


FIG. 6. THE DEEPEST PNEUMATIC WORK: 51-LB. PRESSURE. VIEW TAKEN WHEN SEALING PIER 4, AT DEPTH 113.2 FT.

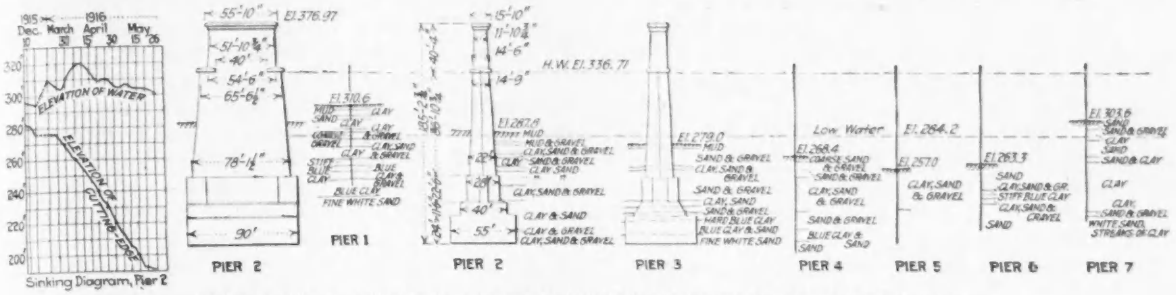
ft. below water, with air pressure of 51 lb. No trouble was experienced, the men working 3¼-hr. shifts with no bad effects.

Caisson 5 showed the best progress of any of the piers, the sinking averaging 2.15 ft. per day through sand and clay. Throughout the job the sinking on all caissons averaged 1.5 ft. per day, or 300 cu.yd. of material excavated.

Two pressure plants on barges were maintained for Caissons 2 to 7, each containing units supplying a maximum of 3500 cu.ft. of air per minute, an electric-light plant for the working chamber and outside light, condensers, pump and hospital lock. A telephone line was also connected with an instrument in the working chamber.

All air lines were run in coils through running water, and the main shafts were protected with corrugated sheets, making a water space. In spite of this, some high temperatures were recorded in the air locks—125° at No. 4—due to the great air pressure and the frequent concreting.

Accurate records of sinking were kept up to date as the work progressed. The location of caissons was checked every morning by triangulation from one of the base lines, and a copy of the report was given at once to the sinking foreman. Fig. 7 shows a combination of the two progress charts for pier 2, made for the permanent record.




FIGS. 7 AND 8. THE SOIL STRATA ENCOUNTERED AT THE VARIOUS PIERS

At left, sinking diagram of pier 2. Cutting edge laid Oct. 10, 1915; total days sinking, 167; delays, 100; actual days sinking, 67; average sinking per day, 1.37 ft.; maximum per day, 3.42 ft.; maximum immersion, 111.5 ft.; maximum pressure, 50 lb. Pier finished July 14, 1916

All concrete was poured with a 1¼-cu.yd. Ransome steam-driven mixer, mounted on a barge with 70-ft. tower and derrick for transferring gravel from barges to feeder bin. Cement was handled from barges loaded from cars at the material dock. The gravel was bar run, furnished by the Union Sand and Material Co., of Memphis, Tenn., and pumped about 13 mi. above the bridge. Five 300-cu.yd. barges and one of 135 cu.yd. were required to keep the mixer going.

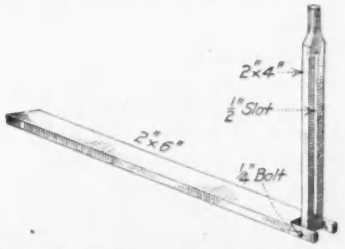



FIG. 10. SKETCH OF TAPE-PULLER

The piers were completed with a derrick boat equipped with a 100-ft. boom seated on a second deck about 22 ft. above the water, giving a total working height of about 115 ft. Concrete was handled in 1-cu.yd. buckets. Steel pier forms furnished by the Blaw Steel Construction Co. were used.

The total excavation on the job was 116,800 cu.yd., of which 103,000 cu.yd. was air work. The total concrete was 93,400 cu.yd., in which 129,000 bbl. of cement and 2,100,000 lb. corrugated bars were used.

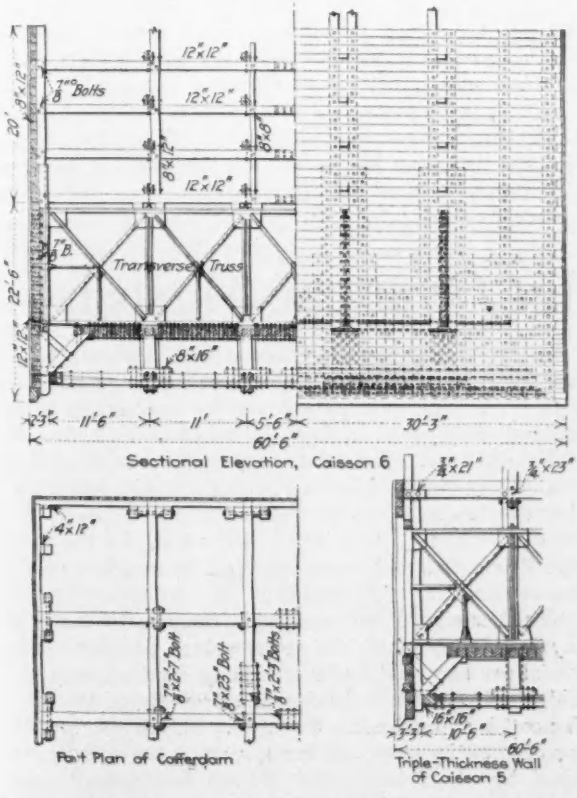



FIG. 9. CAISSON OF PIER 6, AND SECTION SHOWING TRIPLE WALL FRAMING IN CAISSONS

## Some Points in Design of the Piers and Caissons

In the design of piers a maximum toe pressure of 6.5 tons per sq.ft. was allowed, with the following items taken into consideration: Total dead- and live-loads; impact; load of soil on the footing projections; a horizontal load for the fixed end of a span equal to 20% of the total live-load on one track applied at top of rail, and a load of 1% for the expansion end; wind load at 45° over an area of 20 ft. above top of tie, considered as a closed area, and above that 1½ times the area of one truss, and the total area of end bracing for one end; ice, 3 ft.

thick at high water plus current at 10 mi. per hour. Deduction was made for buoyancy, but skin friction was not considered.

Caissons 1 and 2 were of similar type, using a horizontal outside course of 12x12-in. timber and a vertical inside course. The friction plank were vertical, and a wood truss supported the deck. Caissons 3, 4, 6 and 7 were of similar design, but steel trusses (Fig. 1) were used in place of wood on account of the much greater size of those piers (Fig. 9).

Caisson 5, however, was designed with three instead of two courses of 12x12-in. timbers, a vertical outside course, a horizontal middle and a vertical inside course, as also shown in Fig. 9. The friction plank were placed at 45°. Steel trusses were used as in Nos. 3, 4, 6 and 7.

The necessary spread of foundation was secured by three offsets or steps from the shaft width, averaging as follows for the seven piers: First step 6 ft. wide, 23 ft. high; second 12 ft. wide, 11 ft. high; third 15 ft. wide, which carried out to the full width of the caisson and 24 ft. above the cutting edge. In addition to the saving in concrete and decrease in weight, a considerable saving in cofferdam material was effected, as the construction allowed the greater part of it to be cut loose and floated out for use on the remainder of the piers.

### An Open Dredging Pier

Pier 8 was sunk by open dredging, using a concrete caisson 38x63 ft., with 8 pockets separated by 2-ft. walls. Two stiff-leg derricks were used to bucket the material. The caisson was sunk 50 ft., and, the foundation not being as good as the soundings had indicated, wood piles at 3-ft. centers were driven in each pocket, using a set of roller leads working on top of the caisson.

Sealing was done with a tremie made of 10-in. pipe and handled with the derricks. A 9-ft. course of concrete was placed under 40 ft. of water. When pumped out, practically no leaks developed.

Steel erection started on the north approach Oct. 27, 1915. To date the north and south approaches, the 246-ft. deck span and the 720-ft. span have been erected. The erecting of the 720-ft. span was described in *Engineering News*, Dec. 21, 1916.

Two base lines were used in locating the piers, one on the Illinois shore and one on the Kentucky shore, each about 2000 ft. in length. A good location could not be secured for either of these, because there was considerable difference in elevation between the ends and too much angle between the base lines and the bridge center line (Illinois side, 78°; Kentucky side, 87°).

Measurements were taken with a Government-tested 100-ft. tape and thermometer, using pulling and holding standards as shown in Fig. 10. The tape was supported at ends and center; marking was done on zinc strips tacked to the top of 2x4-in. stakes. A small turnbuckle was used on the rear end of the tape to adjust the zero to the stake marking. All measurements were taken at night or rainy days, and corrections were made for temperature, sag and pull. The probable error in the Illinois base line was 1 in 1,500,000, and in the Kentucky line 1 in 2,000,000.

All angles were read 12 times, 6 direct and 6 reversed, using a Buff & Buff precise transit with 8-in. horizontal circle reading to 10″ of arc and equipped with a striding level. The maximum error of closure in any triangle was 3″. No check measurements on center line of bridge have been possible as yet.

The Paducah & Illinois R.R. was incorporated by the Chicago, Burlington & Quincy R.R. and the Nashville, Chattanooga & St. Louis Ry. to build the bridge and about 15 mi. of line from Metropolis, Ill., to Paducah, Ky. The road is now in operation, using a car ferry over the Ohio River.

The late C. H. Cartlidge, Bridge Engineer of the Chicago, Burlington & Quincy R.R., was Chief Engineer of the Paducah & Illinois R.R. and designed the bridge. C. R. Fickes was Resident Engineer in charge of construction and is now Chief Engineer.

The Union Bridge and Construction Co., of Kansas City, Mo., had the contract for the seven river piers, and the American Bridge Co. the contract for fabrication and erection of the superstructure.

# Cantilever Highway Bridge Over the Mississippi

*SYNOPSIS—New bridge for highway and electric railway traffic at Burlington, Iowa, built at such an elevation as not to require a draw span. Financed in an unusual way, and will become the property of the city.*

The new highway bridge across the Mississippi River at Burlington, Iowa, is expected to be completed this spring. It is designed to carry interurban cars, but at first will be used only as a highway bridge, and will be a link in the "Burlington Way" automobile route. It is the first highway bridge at this point, and is located at High St. about a mile above the bridge of the Chicago, Burlington & Quincy R.R. The nearest crossings are at Muscatine, Iowa, about 60 mi. upstream, and at Fort Madison, Iowa (on the bridge of the Atchison, Topeka & Santa Fe Ry.), about 20 mi. downstream. The general design is shown in Fig. 1.

The new bridge was designed by the Wisconsin Bridge and Iron Co., of Milwaukee, Wis., and is being built by that firm. The preliminary surveys and design were under the supervision of J. F. Jackson and C. W. Brooks, of the company. The substructure work was in charge of C. F. Womelsdorf, as Resident Engineer, and F. A. Ross was in charge of the superstructure as Superintendent of Erection. The bridge is being built for the Citizens Bridge Co., which was organized by members of the Commercial Club of Burlington.

The financing of this project is unique, in that the city is helping to pay for the structure by means of a special tax levy, and under an arrangement whereby the bridge will eventually become the property of the city. The cost is approximately $200,000. The city is furnishing $95,000 by means of tax levy; $80,000 will be obtained by sale of bonds, and $25,000 from sale of common stock to members of the Commercial Club. The Citizens Bridge Co. will issue preferred stock to the

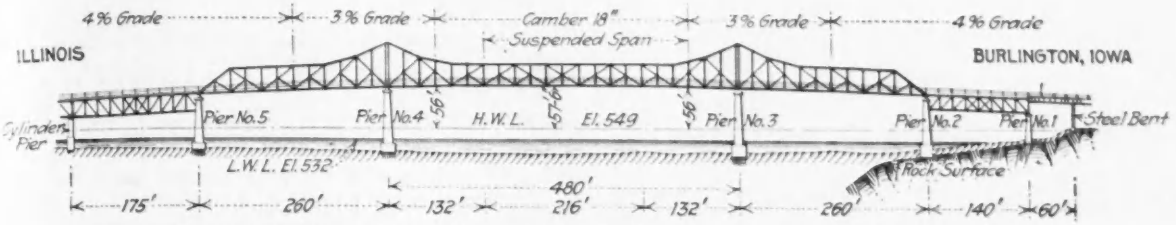



FIG. 1. MAIN CANTILEVER SPANS OF NEW HIGHWAY BRIDGE OVER THE MISSISSIPPI RIVER AT BURLINGTON, IOWA

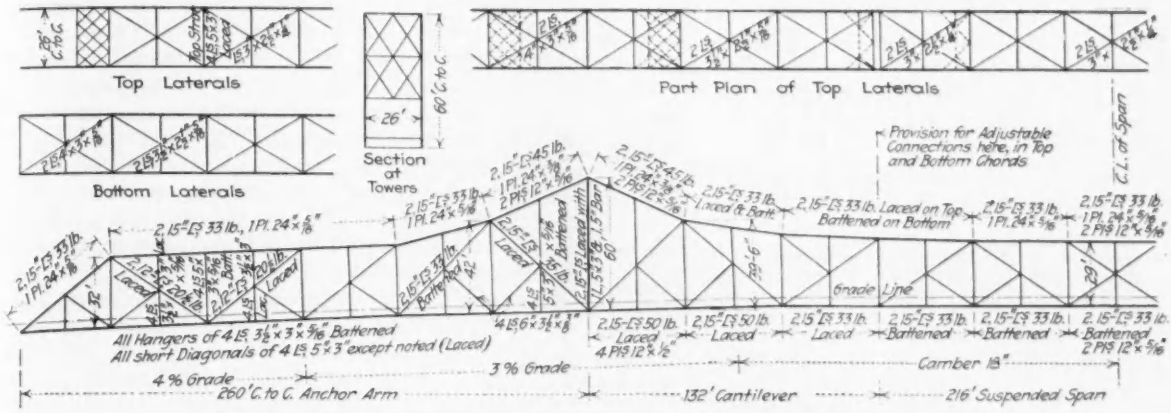

Top Laterals
Bottom Laterals
Section at Towers
Part Plan of Top Laterals
Provision for Adjustable Connections here, in Top and Bottom Chords
C.L. of Span
Grade Line
All Hangers of 4 L's 3½"×3"×5/16" Battened
All short Diagonals of 4 L's 5"×3" except noted (Laced)
4% Grade
3% Grade
Camber 18"
260' C. to C. Anchor Arm
132' Cantilever
216' Suspended Span

FIG. 2. TRUSSES OF THE CANTILEVER BRIDGE AT BURLINGTON, IOWA

city dollar for dollar for taxes collected, and will also give the city a perpetual option on the common stock at par plus 6% interest. By availing itself of this option, the city will own all the stock, and the bridge becomes the property of the city subject only to the bonds outstanding.

The total length of the structure is 2555 ft., and of the steelwork 2463 ft. The main portion consists of a cantilever channel span 480 ft. c. to c. of piers, and two anchor-arm spans 260 ft. long. The channel span is composed of two cantilever arms 132 ft. long, carrying a 216-ft. suspended span. With grades of 4% and 3% a clearance of 56 to 57½ ft. above high water is obtained for a width of about 280 ft. in the channel. This meets the government requirements for navigation and avoids the cost and operating expense of a draw span.

The Burlington (west) approach begins at High St. with 90 ft. of fill between retaining walls, followed by eight girder spans of 30 to 66 ft., and a deck truss span of 140 ft. The outer end of this span is carried by the pier which supports the anchor arm of the cantilever span. The Illinois (east) approach begins at a county levee with a short fill, followed by six girder spans of 50 ft. and 76 ft. 3 in. and four deck truss spans of 120 to 175 ft. The approaches have grades of 4% to the ends of the anchor arms and 3% grades extend thence to the suspended span.

The foundations and masonry work were completed early in December. At that time the superstructure of the Burlington (west) approach had been erected, and also the anchor arm of the main span, while the west cantilever arm had been commenced. On the east side, the girder spans of the approach had been erected. In January the work was done on the ice, piles for falsework being driven, and one 120-ft. east approach span was erected in four days.

The suspended span will be erected from each end as extensions of the cantilever arms, being tied back temporarily to the towers, over the piers. For this purpose the top chord is designed to be a rigid continuous member in erection. When the span is completed the chord will be cut and adjustable connections made between the cantilever arms and the suspended span.

### Substructure Features

The foundations of the west approach and the first two main piers are on rock, which is near the surface. Beyond the second pier the rock falls away by a steep

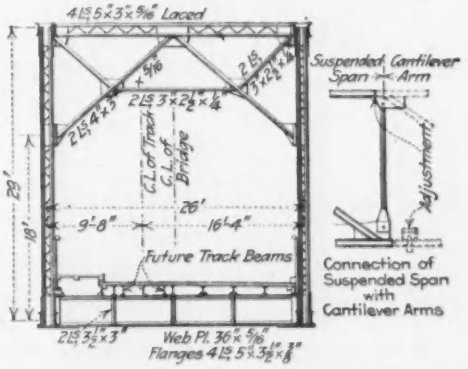



FIG. 3. CROSS-SECTION AND DETAIL OF BRIDGE
Arrangement of points for adjustment at connections of the suspended span with the cantilever arms

slope and all the remaining foundations are on piles driven in the gravel bed of the river and the soft soil of the Illinois side. The substructure consists of four main piers for the cantilever spans and an additional pier for the west flanking span. The girder spans of the west (Burlington) approach have steel bents. All piers for the east approach are pairs of steel cylinders placed over foundation piles and filled with concrete. The main piers have timber piles which were cut off at 8 ft. below low-water and extend about 5 ft. into the hardpan stratum below the sand of the river bed.

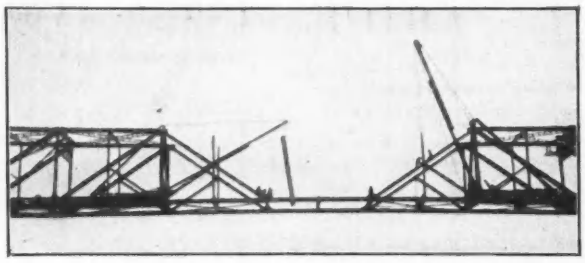


FIG. 4. COMPLETING THE SUSPENDED SPAN

Above the high-water line each pier consists of a pair of concrete pedestals, panelled on three sides, and connected by a 12-in. curtain wall or diaphragm. The pedestals and walls are reinforced with steel rods and angles. The main piers carrying the ends of the deck-truss flanking spans have the central portion (between the pedestals) made much thicker up to the level of the seats for these spans. Pier No. 1 is only 43 ft. high in all and has its two pedestals connected only by diaphragms at top and bottom.

The cylinder piers on the east side were used on account of soft foundation, as they give a relatively light load. Each pier has a pair of cylinders (4 to 5 ft. diameter in different piers) built of $\frac{5}{16}$-in. plates, and in most cases these are telescoped into cylinders of $\frac{3}{8}$-in. plate 5 ft. 9 in. to 7 ft. 3 in. diameter, and 13 to 19 ft. high, with their tops 7 ft. above low-water line. These lower cylinders surround the heads of the 35-ft. foundation piles.

The cylinders are filled with concrete, the filling of the lower and upper sections being bonded together by means of vertical reinforcing rods. Plate-girder struts are riveted between the lower (enlarged) portions of the cylinders of each pier, while the upper portions are connected by girders or angle struts with angle diagonals, according to the height of the pier. The largest piers have 60 to 85 yd. of concrete, while the others have from 22 to 55 yd. The load per pier (including steel, concrete and reaction from weight of spans) is from 80 to 178 tons.

The steel bents for the Burlington (west) approach have posts of 12-in. Bethlehem girder I-beams, battered 1:12, and connected by struts and diagonals. The retaining walls of the filled part of this approach are 12-in. thick, with 30-in. footings, and have 4-in. pilasters (24 in. wide) on the outside, spaced 13 ft. 4 in. c. to c. Drainage is provided by inclined weep-holes of 2-in. pipe. The thrust on the walls is taken up by transverse 1¼-in. tie rods in the panels and pilasters. These are 30 in. below the coping and have nuts and square bearing plates on the outside.

The details of the cantilever span and suspended span are shown in Fig. 2. The trusses are spaced 26 ft. c. to c. and have a depth of 29 ft. in the suspended span, 32 ft. in the parallel chord portions of the arms, and 60 ft. over the piers. The bridge carries a 20-ft. roadway and 4-ft. sidewalk as shown by the cross-section, Fig. 3. There are nine lines of 10- and 12-in. I-beam and channel joists. When a car-track is laid, this will be placed next to the sidewalk. The floor has a lower course of 3½-in. creosoted plank, laid with 6-in. spaces and spiked to wood strips bolted to the webs of the joists. This is covered with a wearing surface of 2-in. oak plank. The sidewalk has a single course of 3-in. plank.

The cantilever trusses are riveted throughout, except that pin connections are provided for the connections with the suspended span. The chords are pairs of 15-in. channels, laced or battened in different panels and in some panels having 24-in. cover plates and 12-in. side reinforcing plates. The main posts (on the piers) are pairs of 15-in. "girder" I-beams, spaced 3 ft. c. to c. (longitudinally) and laced with 3x3-in. angles. The truss posts and other web members are composed mainly of four angles or two channels, with lacing or batten plates. Plate-girder floor beams are framed between the lower ends of the truss posts, and transverse struts between the upper ends. The top and bottom lateral bracing has diagonals in two-panel lengths. The usual sway bracing is provided, and also portal bracing on the inclined ends of the cantilever arms and suspended span.

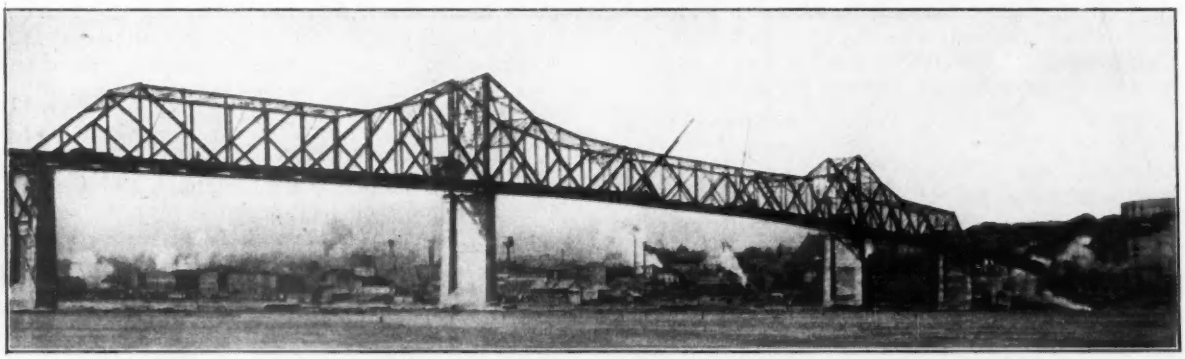


FIG. 5. THE BURLINGTON CANTILEVER BRIDGE. COMPLETED IN FEBRUARY, 1917

In the deck-truss spans, the trusses have top chords of two channels and a cover plate (two angles in the end panels) and bottom chords of four angles with a cover plate or battens on the under side. The posts and diagonals are composed of two or four angles. These trusses have a dead load of 1450 to 1550 lb. per lin. ft. of span.

The bridge is designed for a live-load on the roadway of 2000 lb. per lin.ft., or a 15-ton road roller or 40-ton trolley car with 30-ton trailer, these concentrated loads being placed on the various spans so as to produce the maximum stresses in the floor system. For the sidewalk, the live-load is 100 lb. per sq.ft. The wind load is taken at 20 lb. per sq.ft. on exposed surfaces. The dead-load (exclusive of floor) is about 2200 lb. per lin.ft. for the cantilever arms and 1850 lb. for the suspended span. The weight of steel will be about 800 tons for the three cantilever spans, or a total of 1700 tons for the bridge.

# John S. Dennis, President Canadian Society of Civil Engineers

By A. S. Dawson*

John Stoughton Dennis, the newly elected president of the Canadian Society of Civil Engineers, was born on Oct. 22, 1856, at Toronto. He is the son of Lieut.-Col. J. S. Dennis, the first surveyor general of Canada and subsequently deputy minister of the Department of the Interior.

Mr. Dennis was educated at the Toronto and Kingston grammar schools and at Upper Canada College. He subsequently graduated from the old military school at Kingston, Ont., before the creation of the Royal Military College. When only 16 years of age, he joined a Dominion Government survey party in the Province of Manitoba—then the very Far West; and he played the game so well that two years later he was attached to an extensive trigonometrical survey, establishing longitudes. He served his articles as a Dominion land surveyor with the late Lindsay Russell, assistant surveyor general, and was commissioned as a Dominion topographical surveyor in 1877.

In 1878, he was given charge of a special survey running base-lines between meridians. In 1879 he entered the service of the Hudson's Bay Co., at which time Donald A. Smith, afterward Lord Strathcona, was the head. The land department of that company was organized by Mr. Dennis, and during the following two years he did much exploration work on the Plains and on the eastern slope of the Rocky Mountains.

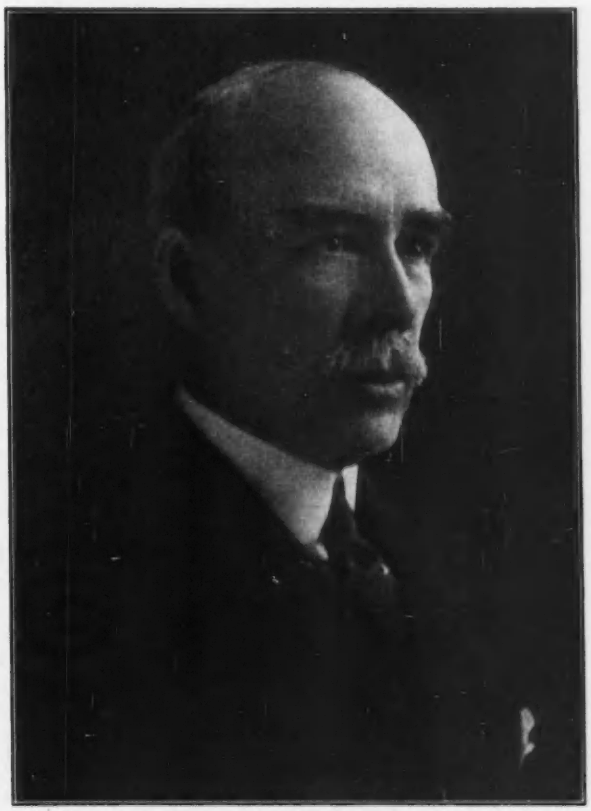
During the Reil Rebellion in 1885, he commanded, with the rank of captain, an intelligence corps of scouts attached to General Middleton's column and made up of surveyors and pioneers thoroughly familiar with the country. He retired with the brevet rank of major in the Canadian militia and with mention for special services at the battle of Batoche.

During the period between 1882 and 1884, he was senior partner of the firm of Dennis, Vaughan & Co., in private practice as surveyors and engineers in Winnipeg. In 1885 he reëntered the service of the Dominion Government. Promotion dogged his footsteps, and in 1892 he became general inspector of surveys in western Canada. In 1896, he joined the service of the Northwest Territorial government as chief engineer and became deputy commissioner of public works in 1897. During this period he was commissioned to visit the irrigated districts of the United States with a view to obtaining first-hand information in connection with irrigation, which it was evident would play an important part in the development of certain sections of western Canada. As a result of this work he took charge of the irrigation surveys and framed the "Irrigation Act," which, with certain amendments, is still in effect. Several large projects proved to be feasible, and most of them have been constructed—the largest being those tributary to the Bow River, east of Calgary, constructed by the Canadian Pacific Railway Co., and serving about three-quarters of a million acres.

In 1902, Mr. Dennis affiliated with the Canadian Pacific Ry., as superintendent of irrigation and chief engineer of the company's large irrigation projects in Alberta. Subsequently he became land commissioner and then assistant to the second vice president, in general charge of all that company's land and irrigation interests in western Canada. In 1912, he was promoted to assistant to the president of the Canadian Pacific, with headquarters at Calgary, Alta., and placed at the head of the Department of Natural Resources, embracing all the company's land, timber and mining interests in the West. In 1916, he was transferred to Montreal as assistant to the president of the Canadian Pacific Ry., and at the head of the newly created Department of Colonization and Development.

During the past 13 years he has had general direction of the building of some of the largest irrigation works in existence, including the noteworthy reinforced-concrete structures known as the Bassano dam and the Brooks aqueduct.

Mr. Dennis has always taken a very keen interest in military matters. As already noted, after the Reil Rebellion he was transferred to the Reserve of Officers with the brevet rank of major; and in 1916 he was gazetted lieutenant-colonel commanding the Calgary battalion of the Reserve Militia. He has always been a man of broad visions, fearless in his convictions, optimistic to a high degree and possessed of unbounded faith in the ultimate place that Canada will occupy among the nations of the world. He is characterized by his fair-mindedness, and has always been a man of quick decision, based on a knowledge of facts. His accomplishments have been the result of a combination of sound judgment and unusual executive ability. His work has left an indelible impression on the history of the development of western Canada.



JOHN STOUGHTON DENNIS

*Chief Engineer, Department of Natural Resources, Canadian Pacific Railway Co., Calgary, Alta.

# Run-Off Computations for 70,000-Acre Storm-Water Drainage, St. Louis

The report on storm-water drainage for the River des Peres district, by W. W. Horner, Chief Engineer of Design, adopted by the Board of Public Service of St. Louis recently, brings out clearly the method of sewer design now used in St. Louis. Its application to so large a project is somewhat unusual. (See *Engineering News*, Feb. 1, 1917, p. 209. The drainage area involved totals 70,000 acres.) An abstract of portions of Mr. Horner's report follows:

Up to 1907 St. Louis was using the McMath formula in its sewer design. The known irrationalities of this formula and the dissatisfaction with the results obtained finally led, in that year, to the beginning of a new study of rainfall in connection with sewer design, and shortly thereafter the formula was rejected in favor of an application of the rational method of design. In this respect the St. Louis experience was not greatly different from that of other cities doing large sewer work.

At that time the city secured all the available records of the St. Louis Weather Bureau station and from these prepared a rainfall curve that was used for several years. The data of the Weather Bureau, for short storms, extended back to only about 1900, and for the longer storms figures were not always given for the total precipitation in two and three hours. The city installed its own gages in 1910, and the record of these gages, together with those originally obtained from the Weather Bureau, later made it advisable to revise the curve first adopted.

The revised rainfall curve as now used in St. Louis is shown as a long dash line in Fig. 1. It will be noticed that the intensities on this curve have been exceeded at least once and in some cases three times for any particular duration, which would indicate that, if all other considerations of the design were correct, the sewers would probably be overcharged somewhat at intervals of about 15 or 20 years.

During the latest studies of the River des Peres scheme the question of allowing this drainage system to be overcharged at long intervals, as is permitted in the case of ordinary sewers, was reconsidered. Even though such an overcharge might occur only once in 25 yr. and even though the damage occasioned at such a time would be considerably less than the interest on the additional expenditure required to avoid it, the continually growing demand for a higher class of service from all improvements was taken into account, and it did not seem impossible that at some time in the future the sentiment following such an overcharge might force the provision of additional sewerage facilities. If this should occur, it would prove to be enormously expensive, particularly in the western part of the system; and it was therefore decided to recommend that the sewers be built to carry any flood that could reasonably be presumed.

For the purpose of the River des Peres design, therefore, a new intensity curve was prepared, which is the upper curve shown by a full line in Fig. 1. As shown by the plotted points, the intensities of this curve have been exceeded several times, but only for the shorter rains;

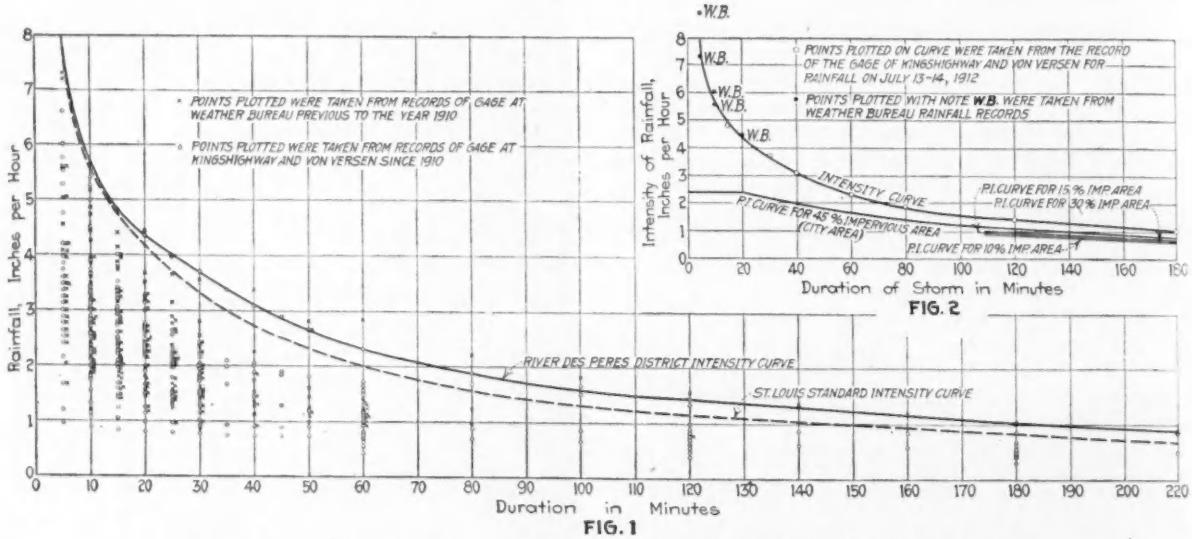

Rainfall, Inches per Hour
Duration in Minutes
POINTS PLOTTED WERE TAKEN FROM RECORDS OF GAGE AT WEATHER BUREAU PREVIOUS TO THE YEAR 1910
POINTS PLOTTED WERE TAKEN FROM RECORDS OF GAGE AT KINGSHIGHWAY AND VON VERSEN SINCE 1910
RIVER DES PERES DISTRICT INTENSITY CURVE
ST. LOUIS STANDARD INTENSITY CURVE
W.B.
Intensity of Rainfall, Inches per Hour
POINTS PLOTTED ON CURVE WERE TAKEN FROM THE RECORD OF THE GAGE OF KINGSHIGHWAY AND VON VERSEN FOR RAINFALL ON JULY 13-14, 1912
POINTS PLOTTED WITH NOTE W.B. WERE TAKEN FROM WEATHER BUREAU RAINFALL RECORDS
INTENSITY CURVE
P.I. CURVE FOR 15% IMP. AREA
P.I. CURVE FOR 30% IMP. AREA
P.I. CURVE FOR 45% IMPERVIOUS AREA (CITY AREA)
P.I. CURVE FOR 10% IMP. AREA
Duration of Storm in Minutes

FIG. 1

FIG. 2

RAINFALL INTENSITY AND RUN-OFF CURVES FOR SEWER DESIGN, ST. LOUIS, MO.

In the beginning of these studies the St. Louis engineers could find few reliable data on the measured run-off from sewer districts. Even the more recently published report from the Boston Society of Civil Engineers on this subject gives results that vary widely, and so many local conditions are involved that it is difficult to draw conclusions. St. Louis, therefore, in 1910 initiated an independent set of experiments on this subject and had a large number of sewer and rain gages installed in different drainage areas. These experiments have been continued on a large scale, but the data thus secured have not yet been completely analyzed. From a portion of the and it was shown later that the design of the River des Peres system was not affected by the intensities within the 2-hr. time.

TABLE 1. RUN-OFF FACTORS FOR VARIOUS PERCENTAGES OF IMPERVIOUSNESS

| Duration Min. | % Run-Off from Impervious Portion | % Run-Off from Pervious Portion | Average % for Classes of Areas Having Following Amount of Impervious Area 10% | 15% | 30% | 45% |
|---|---|---|---|---|---|---|
| 10 | 50 | 20 | 22.0 | 26.0 | 32.0 | 38.0 |
| 15 | 70 | 30 | 31.0 | 36.0 | 42.0 | 48.0 |
| 20 | 80 | 35 | 36.0 | 41.75 | 48.5 | 55.25 |
| 30 | 85 | 40 | 40.5 | 46.75 | 53.5 | 60.25 |
| 60 | 95 | 50 | 49.5 | 56.75 | 63.5 | 70.25 |
| 120 | 95 | 60 | 57.5 | 65.25 | 70.5 | 75.75 |

TABLE 2. COMPUTATIONS FOR THE TIME OF CONCENTRATION OF THE NORTHERN BRANCH OF RIVER DES PERES AT THE CITY LIMITS OF 1876*

| Station to Station | Average Area of Cross-Section, Sq. Ft. | Hydraulic Radius R, Ft. | R0.62 | Length, Ft. | Slope, Ft. per Ft. | n | Velocity, Ft. per Sec. | Time, Min. | Total Time, Min. |
|---|---|---|---|---|---|---|---|---|---|
| 0+00 to 11+25 | | | | | | | | | 10.00 |
| 11+25 to 23+25 | 10 | 0.64 | 0.758 | 1,200 | 0.0187 | 0.035 | 4.6 | 4.35 | 14.35 |
| 23+25 to 42+75 | 12 | 1.04 | 1.006 | 1,950 | 0.01055 | 0.035 | 4.6 | 7.06 | 21.41 |
| 42+75 to 93+00 | 20 | 1.42 | 1.24 | 5,025 | 0.0084 | 0.035 | 5.0 | 16.75 | 38.16 |
| 93+00 to 167+25 | 80 | 2.42 | 1.73 | 7,425 | 0.0056 | 0.040 | 5.0 | 24.75 | 62.91 |
| 167+25 to 242+25 | 150 | 3.24 | 2.07 | 7,500 | 0.0034 | 0.040 | 4.7 | 26.60 | 89.51 |
| 242+25 to 254+25 | 280 | 5.00 | 2.71 | 1,200 | 0.00242 | 0.035 | 5.9 | 3.39 | 93.90 |
| 254+25 to 289+25 | 280 | 5.00 | 2.71 | 3,500 | 0.00242 | 0.025 | 8.3 | 7.03 | 100.93 |
| 289+25 to 333+00 | 450 | 6.50 | 3.19 | 4,375 | 0.00188 | 0.025 | 8.6 | 8.48 | 109.41 |
| 333+00 to 387+00 | 30 ft. horse-sh. | | | 5,400 | | 0.013 | 12.1 | 7.44 | 116.85† |

* The formula used in these computations is as follows:—$V = \frac{1.55}{n} \times R0.62 \times S0.50$ † 116 min. is taken as the time of concentration.

records, however, it appears that a rather definite idea of the amount of run-off from sewers in the typical residence section in St. Louis has been gained.

In applying the run-off factors with the amount of impervious area taken into account the run-off coefficients for several values of impervious percentages were used as given in Table 1.

The intensity curve given in Fig. 1 is reproduced as the upper curve in Fig. 2, and by multiplying the ordinates to this curve by the run-off factors in Table 1 values are found for plotting the lower curves giving rates of run-off for various percentages of imperviousness.

It will be noticed that, because the percentage of run-off has been estimated to increase with the duration of the storm, the run-offs per acre vary but little for the long storms that are critical for the River des Peres. For that reason any errors in the assumptions of the future conditions of imperviousness will have a comparatively small effect on the amount of run-off.

While a large part of the River des Peres watershed within the City of St. Louis is sewered, only a small part of the county area is now thickly populated; and it was necessary to predict the probable growth of the city and the character of occupancy in that portion of the watershed beyond the St. Louis limits. In doing this, local conditions, the present trend of growth and transportation facilities had to be taken into account. In the final analysis the portion of the watershed of each branch near the city limits was assumed to reach a second-class urban development, and the percentage of imperviousness of 30 was assigned to this class. Beyond this a second portion of the area was assumed to become finally a large suburban community and was given a percentage of imperviousness of 15. It was decided that the remaining, or most remote, area would never be more than semirural, and the percentage of imperviousness was taken at 10.

In the application of these values by the rational method to the design of the main drainage system it was first necessary to determine the probable time of concentration of the flow at the city limits. For this purpose careful surveys were made of the natural channel between the city limits and the extreme watershed. The length of the channel, grades, channel section, high-water marks and lateral slopes of ground were obtained. In the computation of the time given in Table 2, it was assumed that the channel throughout the section of the first class mentioned above would be partly improved and that through the second and most remote sections nothing more than straightening would be done.

From Table 2 it was found that the time required to concentrate the run-off of excessive rains at the point where the channel first entered the city limits is 116 minutes.

With this value of 116 min. as the critical time at the city limits and the run-off factors for the various classes of impervious areas taken from the discharge curve, Fig. 2, the run-off shown by Table 3 results.

TABLE 3. SUMMARY OF AREAS TRIBUTARY TO END OF SEWER AT CITY LIMITS

| | Sec.-Ft. |
|---|---|
| 30% impervious, 1,752 acres at 1.01 sec.-ft. per acre | 1,770 |
| 15% impervious, 3,591 acres at 0.96 sec.-ft. per acre | 3,447 |
| 10% impervious, 4,700 acres at 0.92 sec.-ft. per acre | 4,324 |
| Run-off of North Branch at city limits | 9,541 |

The resulting value, 9539 cu.ft. per sec., is very much greater than the discharge of any flood that has occurred to date; but it is clearly indicated, if the predictions of future development of the county territory are approximately correct.

The other county areas were treated in a manner similar to that given above for the North Branch.

The report shows that the run-off is much greater than any recorded for watersheds of similar size, but calls attention to the fact that there is no record of a watershed of this size which is sewered to the extent that this one would be; and if this is taken into consideration with the proposed development of the whole valley as industrial property, it is evident how great the damage might be in the future, if sufficient provision is not made at this time.

The largest size of closed sewer proposed in the report (a double arch of 29 ft. width) will carry nearly 14,000 cu.ft. per sec.

**The Need of Topographic Maps for Aviators** was explained by E. Lester Jones, Superintendent of the United States Coast and Geodetic Survey, in a paper read at the Pan-American Aëronautic Exposition in New York City, Feb. 9. It is well understood that as a means of coast defense the United States should have a large force of aëroplanes, which may be required to operate at any place along its coast. Where aviators cover long distances, as they are often obliged to do, the need of a good topographic map as a guide is very great. Unfortunately, a large part of the coastal area of the United States is still unmapped. There is no topographic map of any part of our Atlantic coast south of Norfolk, Va., and of many parts of the coast north of that place; nor is there a single place along the gulf coast where we have any topographic maps. An exception is made of the narrow strip of topography 3 mi. wide which is mapped by the Coast Survey in connection with its hydrographic charts, but this is too narrow to be of much service for aviation charts. From the pressure of other work the Coast Survey has not kept up its land-topography work in recent years. Mr. Jones further stated that there is a movement now in military circles to start the systematic mapping of a strip approximately 20 miles wide along the entire coast line of the United States, which appears to be the minimum amount that under modern conditions of warfare will be needed for the defense of the coast and the movement of troops along them. At places, this width of 10 miles must be increased to 40 or 50 miles. Mr. Jones also urged a large extension of wire-drag surveying to discover deep underwater reefs, which while not dangerous to ordinary vessels might prove fatal to submarines when operating submerged.

# Railway Grade Changes in Two Cities

The elevation of tracks through cities is one of the most important duties now before railway companies and one that occupies most of the efforts of their construction forces today. In this article are described the main features of two such jobs, one at Jamestown, N. D., now about completed, and one at Aurora, Ill., now under way. The two constructions are somewhat similar, and each has some peculiarities in the concrete structural design.

### New Station and Elevation at Jamestown

The improvements by the Northern Pacific Ry. at Jamestown, N. D., included the elevation and rearrangement of tracks, the construction of a retaining wall and a large street subway and the building of a new station. The work was done at the same time as the construction of a sewer system by the town, and the railway paid part of the cost of this instead of building its own sewer outlet to the river. This coöperation of the railway company and the municipality for their mutual benefit is an interesting feature of the work. The sewer system was described in *Engineering News*, Feb. 22, 1917.

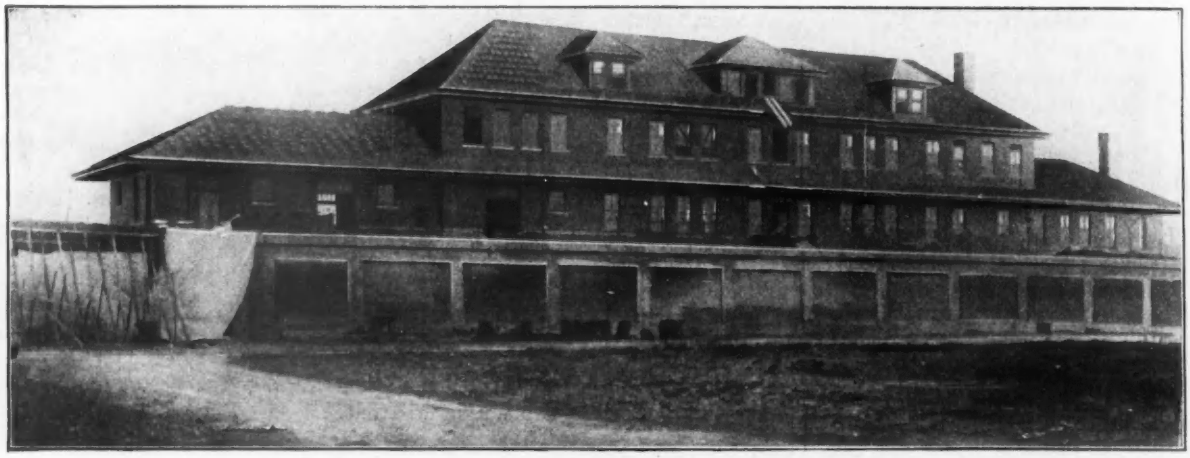


FIG. 1. NEW STATION AND TRACK ELEVATION ON THE NORTHERN PACIFIC RY. AT JAMESTOWN, N. D.

Jamestown is a division point on the main line and the starting point of two branch lines (to north and south). As in many Western towns, the railway runs through the center, and there are two main streets alongside the right-of-way, with stores and hotels fronting upon the railway. The tracks have been raised for 2100 ft. east from 5th Ave., which is one of the principal cross-streets. The maximum elevation is 6½ ft. This change eliminates a sag in the grade and a enables a 60-ft. subway with 13-ft. headway to be put in at 2nd Ave. The main sewer of the new system crosses the railway at this street, and an outlet sewer runs along the south side of the tracks (on the railway right-of-way) west to the James River.

The new passenger station (Fig. 1) is at 2nd Ave., its east foundation wall forming a part of the abutment for the subway. It is 231x38 ft., with station facilities on the first floor, division operating offices on the second and engineers' offices on the third floor. The building is of wood framing with Hebron pressed-brick walls, blue Bedford stone trimmings and green tile roof. A passage and stairway lead from the main waiting room to the sidewalk in the 2nd Ave. subway.

The foundations for the building are concrete retaining walls at the sides and columns in the interior space, as shown in Fig. 2. The ground on the site of the station is 12 to 15 ft. below the new grade of the tracks, necessitating high foundation walls. These walls are of a thin reinforced-concrete type, the wall acting as a beam between the footing course and the concrete floor of the station, to both of which it is keyed and connected. The footing was carried down into a shale formation, and the concrete was poured directly into the trenches (without side forms), thus making a toe that is well anchored in the ground to resist inward thrust. The floor slab is 5½ in. thick, reinforced with wire mesh, and is formed monolithic with beams between the columns. The reinforcement of the wall (along its inner face) consists of horizontal bars 24 in. apart and vertical bars spaced 6 in. apart in the lower portion and 12 in. in the upper portion.

There will be two passenger and two freight tracks, two pair of stub tracks for trains of the branch lines and three coach-storage tracks. In front of the building is a platform 21½ ft. wide, with ends 13 ft. wide, extending between the main and stub tracks. There is also a 13-ft. island platform between the main passenger tracks. These platforms are 1100 ft. long, paved with brick, and have concrete curbs. The space between curbs is 9 ft. For cleaning cars on the coach tracks there are hydrants and boxes concealed in the island platform.

The main floor is at the track level and is reached by an inclined approach behind the station. This approach has a 10-ft. cement sidewalk and a 26-ft. roadway (with 54-ft. turning space) paved with sandstone blocks. The sidewalks and roadways are drained by side inlets to a drain under the sidewalk slab, with 12-in. vitrified-pipe connections to the storm-water sewer.

The 2nd Ave. subway, shown in Fig. 2, is 60 ft. wide, the full width of the street. It is of unusual length, 168½ ft., as it carries not only the tracks and platforms, but also the 54-ft. carriage space and 10-ft. sidewalk at the summit of the inclined approach. It is of reinforced

concrete throughout, with two side spans of 12 ft. and two middle spans of 20 ft., carried by three bents having arched openings between a series of rectangular columns spaced 7 ft. 5 in. c. to c. Beneath one of the roadways is a main storm sewer 38x48 in., with a vitrified-pipe domestic sewer below it.

To construct the slab spans, it was necessary to cut out the tracks two at a time, remove a temporary bridge at the site and pour the slabs up to the nearest expansion joint.

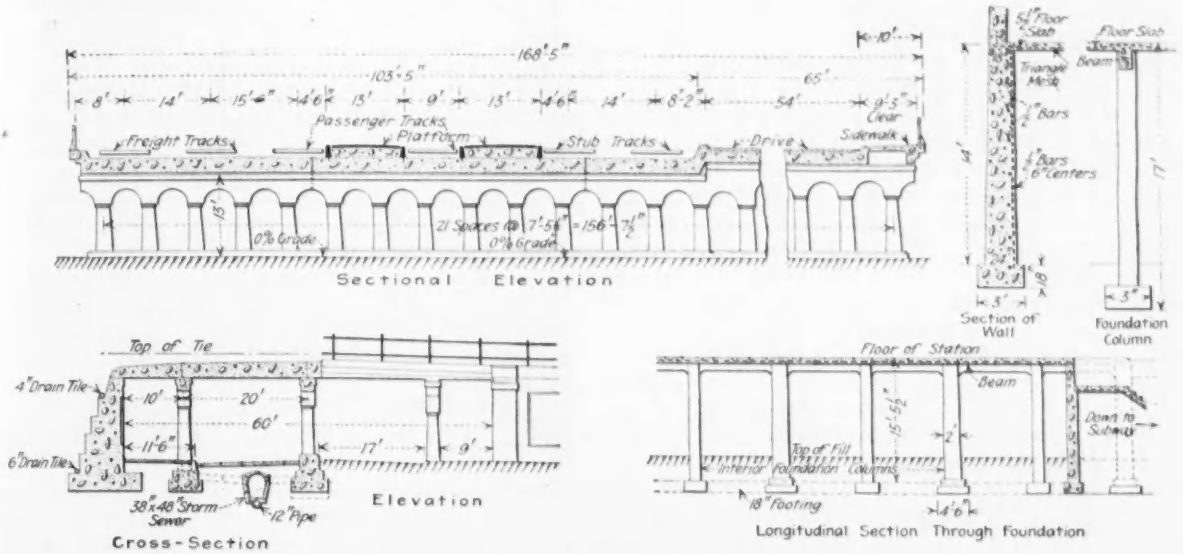



FIG. 2. DETAILS OF SUBWAY AND RETAINING WALL AT STATION IN JAMESTOWN

The spans are reinforced-concrete slabs cast in place. Each span is made in four sections (with longitudinal joints), the two outer sections being about 40 ft. wide and the two inner sections 44 ft. wide. The ends are treated ornamentally and carry hand railings. The top of the deck has a waterproof covering and is sloped toward the ends to shed water. Drainage is provided by tile drains under the platforms and laid along the top and bottom steps at the back of the abutments and retaining walls.

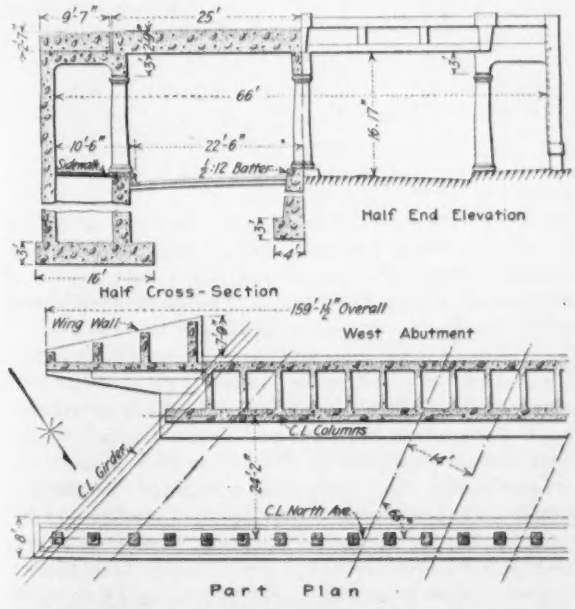



FIG. 3. SUBWAY OF REINFORCED-CONCRETE AT NORTH AVE., AURORA, ILL.
Note the special type of foundation for abutments and sidewalk bents

The total estimated cost of the work is $165,000, distributed as follows: Station, retaining wall and subway (contract price), $112,000; track and grade changes, $24,000; sewers and drainage on right-of-way, $8000; miscellaneous, $21,000.

The E. G. Evanstad Co. had the contract for the station, retaining wall and viaduct. Track and grade changes are made by the railway forces. The railway company also makes a voluntary contribution toward the expense of the town sewer system, the amount being equal to the cost of constructing the company's own outlet to the river. The work was designed and constructed under the direction of W. L. Darling, Chief Engineer (recently resigned), and H. E. Stevens, Bridge Engineer (now Chief Engineer), Northern Pacific Ry. Louis Yager is Division Engineer, and P. W. Stickney, Assistant Engineer, is in direct charge of the work. The sewer system was designed by L. P. Wolff, Consulting Engineer, St. Paul, Minn.

### Railway Changes at Aurora, Ill.

The main line of the Chicago, Burlington & Quincy R.R. has a long sag in the grade line at Aurora, Ill., in order to pass through the city at the street level; and west of the river it has a long reversed curve location through an industrial district, with a bridge over the Fox River. The city has required the elevation of the tracks, and in connection with this the main line has been relocated for a distance of about four miles. This not only eliminates undesirable curvature, but improves the grades by reducing the sag. The maximum grade will be 0.3%.

East of the city a long easy curve will replace the present line and provide for a better arrangement of the freight yards. Through the city the old location is retained, but the line will be on a fill with retaining walls. The right-of-way is also widened for five tracks, involving considerable expense for property acquired. West of the city a relocation eliminates the reversed curves and

gives a direct line, crossing the river at an island and requiring a bridge for each channel. Near the river the new line crosses an abandoned stone quarry, requiring a considerable fill. The old line will be continued in service, as it serves a number of industries.

The two bridges over the Fox River have concrete arch spans of 65 ft. in the clear, with spandrel arches carrying a concrete deck. The one over the east branch has two arches, while the one over the west branch has three arches. These will carry five tracks spaced 14 ft. c. to c. The piers and abutments will be built of full length to above the ordinary water level, but the arches and upper parts of the piers will be built only for three tracks at this time.

The foundations consist of concrete cylinders 4 ft. 3 in. in diameter, built in open pits. For each pier there are two rows of cylinders, sunk to rock at depths of 25 to 35 ft. They are spaced 16 ft. c. to c. longitudinally and 9½ ft. c. to c. transversely. The materials encountered were gravel and clay. The foundation work will be carried on during the winter, but the arches will not be started until next summer. For this work there are three stationary mixer plants, with 1-yd. mixers and 98-ft. elevator towers supporting inclined steel chutes. Between the two bridges will be about 1300 ft. of ordinary fill, across the island.

The subways will have reinforced-concrete bents and abutments with decks of precast concrete slabs. The North Ave. subway shown in Fig. 3, is typical of these structures, except that it is of unusual length, carrying six or more tracks at various angles. A peculiar feature is that of putting each abutment and curb-line bent on a single foundation slab considerably below the street level, the space being subdivided by crosswalls under the sidewalk and ribs extending from the abutment to the columns of the bent. This design was adopted in order to reduce the amount of concrete in view of the fact that at this point the depth of foundations is about 20 ft. The columns are rectangular, with chamfered edges. The wing walls are of the counterfort type. Wood forms are used, except that for the molded bases of the columns there are cast-iron forms which are made at the railway company's shops. The uprights of the column forms rest on these castings.

This new work will cost about $4,000,000 and will be completed (for three tracks) in about two years. The construction is being done entirely by company forces. It was planned under the late T. E. Calvert, Chief Engineer, and is under the direction of W. L. Breckenridge, Engineer of Maintenance-of-Way. W. Pringle, Assistant Engineer, is in resident charge of the work.

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**An Investigation of Sewer Bids** at Portland, Ore., by a committee of three members of the Oregon Association of Members of the American Society of Civil Engineers was recently requested by the City Council, acting on rumors of collusion in bidding. At a meeting of the Association to discuss the request it was urged that the estimate of City Engineer Philip H. Dater, was made in August, 1916, since when the price of materials, particularly steel, and of labor, has gone up; also that the work is hazardous and that the contract provides for no payment until the work is completed and accepted. For these reasons it is said that it is no wonder the lowest bid, made by J. P. Shea and William Lind, was 10 to 12% above the estimate, or $302,800 compared with $273,000. At last reports the Association was to take a ballot on the request, with the understanding that the three highest nominees would be designated as an investigating committee.

## Using Light Motor Trucks for Construction Work

The use of the lighter class of motor trucks, similar to delivery wagons, for service on construction work is a special field offering extensive opportunities, but which as yet has not been developed to the same extent as the employment of large trucks (especially those of the dump-body type). Many builders make trucks of ¾-ton to 2½-ton load capacity, and there are special attachments by which automobiles can be converted into trucks of about 1-ton capacity.

These light trucks are strong and serviceable, with good overload capacity, and they are economical in cost of operation and maintenance or repair. It is obvious that for economical service a good and careful driver is essential, but it is astonishing what rough usage the trucks will stand, either in careless handling or in getting over rough ground. Very frequently they are run with light loads, when necessary to give prompt delivery of material, machinery, repair parts or men. In such cases time is the all-important factor. On the other hand, they not infrequently carry loads far above the rated capacity. Such trucks are operated mainly on paved streets and country roads, but can negotiate the rough tracks around construction work or even travel across country.

The bodies are of different types, but the most common form for this class of machine is the low-side box body. Typical designs are shown in Figs. 1 and 2, the former being an International truck with cab, and the latter showing some Overland trucks with automobile hoods. Tank bodies may be adopted for hauling water or oil. Dumping bodies are not frequently used, as it is rarely desirable or economical to handle excavated material in small lots.

On the other hand, for such jobs as excavation for buildings a contractor may find a light dump-body truck of assistance, especially if it is convertible into a delivery truck. A machine of this class with 1-ton side-dump body was described in *Engineering News*, of July 27, 1916.

The advantages in speed, range of action and readiness of service afforded by the light trucks have long been recognized by dealers in material and supplies, and also by municipal departments. The same advantages apply also in much construction work, and many contractors have already added such cars to their equipment. In building work especially their value is in being able to make prompt and frequent delivery and to serve a number of jobs. Their advantages over horse-drawn trucks are largely in ability to make numerous runs in the city or to make long and quick runs to distant jobs. The possible daily mileage is immensely greater than with a team. The team also must have periodical rest; and if horses are overworked (in speed, load or length of service), they require time to recover normal condition.

There is also the "emergency" advantage in making it possible to supply material quickly when needed, whether within or beyond the range of a team. The lack of drill steels, a few sacks of cement, a repair part, a little lumber, etc., may cause an expensive delay, holding up the work of a large crew. But with a light motor truck such troubles—which will occur on construction work in spite of all foresight—can be taken care of easily.

Some supply firms dealing in building material have found that having light trucks for long trips reduces the cost of delivery to such an extent that out-of-town jobs can be figured at lower prices than when teams were used. With the latter also there is likely to be unsatisfactory delivery in distributing materials to various buildings in different parts of a city. In fact, a dealer in such supplies has reported that a 1½-ton truck gives better service than three double teams and has practically

FIG. 1. MOTOR TRUCK USED TO CARRY A CONCRETE MIXER AND BUILDING MATERIAL

eliminated complaints from customers as to delays in delivery.

A 2-ton truck is used by the Dravo Contracting Co., of Pittsburgh, Penn., for hauling supplies and machinery parts from the city to the company's works at Neville Island and from these works to various contracts in the vicinity of Pittsburgh. The average trip is 15 miles (in one direction) and the maximum about 25 miles. The hauling is done on city streets, country roads and the temporary driveways on the construction jobs. This truck is in constant service. A 1½-ton Kelly-Springfield truck

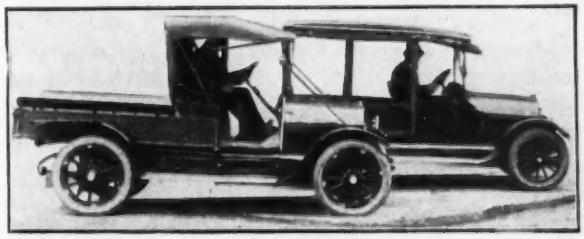


FIG. 2. TWO LIGHT MOTOR TRUCKS USED BY A CONTRACTING FIRM

is utilized by the T. J. Pardy Construction Co., of Bridgeport, Conn., in hauling building materials from cars to various jobs and to different cities. Most of the hauling is in towns, but some on country roads. The length of trip is ordinarily 2 to 5 miles, but trips from town to town may be 10 to 60 miles long. The cost of operation and maintenance is small, and the work is done so quickly that delays in supplying small quantities of materials are eliminated. It is estimated that this truck will pay for itself in 1½ to 2 years. Both the companies named above turn to the trucks occasionally to transport men.

On tunnel work in New York the contracting firm of Booth & Flinn (of Pittsburgh) used a White truck to handle drill steels. The drills were sharpened at a central plant, and the truck distributed them to the various shafts and brought back the worn drills. A rather unusual service is hauling a concrete mixer from place to place. This has been done extensively by W. Polcyn, a Chicago building contractor, with an International truck (Fig. 1). A suggested modification of this plan is to mount the mixer permanently on a trailer, saving the time of loading and unloading the machine.

Still another interesting example is the operation of a Smith "Form-a-Truck" (converted from a Ford automobile) by the Thompson-Starrett Co., of Chicago, during the construction of houses for the United States Steel Corporation at Gary, Ind. There are 200 of these houses, scattered over different locations. The concrete foundations are of uniform design, and the forms are used over and over again. In moving the forms the motor truck effects a great saving in cost and especially in time as compared with a team. When the forms are stripped from one building, they are loaded upon the truck, with a crew of carpenters, and quickly taken to the next site and erected. The truck is used also in distributing materials to the different sites.

There is a reverse side to the question, of course, and one firm of contractors for public works reports that it has found motor trucks more expensive than team service. They have employed light trucks in transporting gangs of men for 8 or 9 miles and say that the only saving here was the men's working time. But this in itself may be an important saving in some cases. This firm believes that for hauls up to 4 miles materials can be transported 25% cheaper with teams than with motor trucks. It considers 6 miles as the minimum haul for trucks and that even then the roads must be first class if the trucks are to show a saving over transportation by teams. The factors of speed and frequency of service are not mentioned and perhaps were not important.

It is difficult to make any close comparison of cost of service with motor trucks and horse wagons, but the former has been estimated at 30 to 50% the cost for the latter. But the greater speed, the possibility of more frequent service or of covering a greater mileage and the fact that the machine is ready at all times may be quite as important as a saving in cost. For a 1-ton truck costing $1525 the fixed charges and operating expenses have been figured at $591 and $1857 per year. This is compared with $1370 for the cost of two double teams and wagons, and annual charges of $891 and $3240. On a basis of 313 working days these figures show a total daily cost for fixed and operating charges of $7.82 for the truck and $13.20 for the teams.

The light motor trucks are of advantage also in municipal service and are used by water-works and other departments in transporting supplies and men. They make excellent supply and repair wagons (with or without towers) for electric-railway, telephone and telegraph companies.

Closely related to the selection of light motor trucks to serve construction work is the use of automobiles by engineers and superintendents on such undertakings. In this way they can cover more jobs and still give more time to each than with the horse and buggy equipment that is now becoming obsolete. The automobile also has the same "emergency" advantages as the motor truck in speed and readiness for service. In fact, one large firm of contractors says it would no more think of conducting its business without its automobiles and light delivery trucks than without telephone service.

# Classification Surveys for Assessment Purposes in California

By Earl A. Marshall*

Classification surveys of agricultural lands for assessment purposes has recently become the practice among county and state officials in California. This work has consisted of making soil and topographic surveys and maps, to show the boundaries of the different types of soils, and grading them as numbers 1, 2 or 3 of each type, or as unfit for cultivation, and showing all areas in permanent crops, such as orchards, vineyards, alfalfa, hops, etc. All important topographic features are also shown, such as streams, dry channels, irrigation or drainage ditches, levees, roads, buildings, fences, brush or timbered areas, gravel bars, etc.

These maps have been made by compass and pacing surveys, platted in the field. The finished maps have been made on white paper with colored inks and show all soil acreages, acreages in each permanent crop, in county roads, right-of-ways, etc. The maps of a given area are accompanied by a report on the soils of that area, discussing for what crops they are best adapted, comparing their values, discussing irrigation or drainage possibilities and giving other data of value.

In California the type of soil is the most important consideration in fixing land values; yet heretofore it has been taken into consideration by the assessors only in a very indefinite way, if at all. In many cases the same type of soil at one end of a county is assessed twice as much as at the other, even though at the same distance from market; in other cases all the lands of a certain district are assessed at the same rate, even though certain soils there may be worth five times as much as others. The inequalities shown up have been so great that it is the intention of the State Tax Commission to recommend that the next legislature adopt a bill providing that the counties classify their lands, under state supervision. The methods that will be recommended are those described here.

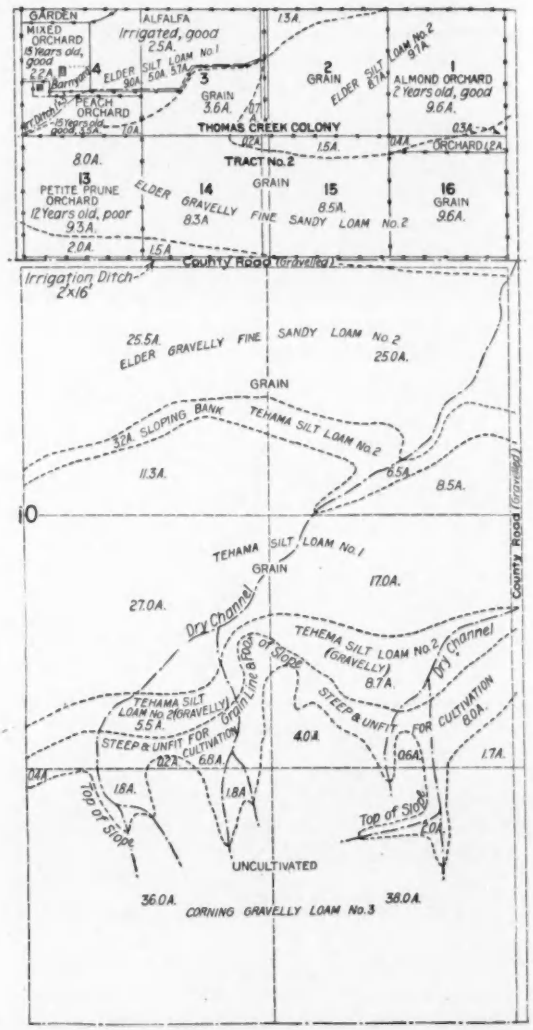
### Instruments Used and Methods of Fieldwork

As before stated, the fieldwork is done by compass and pacing surveys, the topography being platted in the field. As a base to work from, all deeds, recorded surveys, or private surveys if obtainable, are platted on the map before entering the field. Where no better information is obtainable, it may be necessary to work to the original Government public-land survey; if this is badly in error, certain lines should be chained.

For taking the topography either a sight compass on a Jacob's staff has been used and the map platted on cross-section paper, or a traverse plane table similar to that of the United States Geological Survey has been used. The traverse table is the best and most convenient. Even with it, however, it is often easier to take unimportant bearings with a box compass held in the hand and plat them with a protractor. The scale used has been 16 in. to the mile, or 1 in. = 5 chains = 330 ft. By the use of cross-section paper no platting or scaling is necessary for lines run north and south or east and west.

Where the entire section is agricultural land, the examiner usually goes along the "forty" lines, covering a strip of 660 ft. on each side. He plats the position of all required objects accurately, pacing out for side shots the entire 660 ft. if necessary, and returning to carry the main line along. If he is surveying along a creek or bank, he usually traverses it, platting as he goes. For this it is best to have a scale of paces.

Where possible, the surveyor goes east, west, north or south for the side shots. Unimportant or indefinite boundaries are usually sketched. On the return, on a line parallel and a quarter of a mile over, the surveyor




**SAMPLE LAND-CLASSIFICATION MAP**

**Original map is 10 x 17 in. The legend reads as follows:**

**EAST ½ OF SEC. 10, T.24N.R.4W., MT. D.M.**
**TEHAMA COUNTY, CALIFORNIA**
**E. A. M. Aug., 1916.**

**CONDENSED REPORT ON SOILS**

**The Elder Silt Loam is a smooth textured silt loam, easy to cultivate, and very retentive of moisture. It is well adapted to apricots, peaches, almonds, etc., and alfalfa. Irrigation is desirable, but not necessary. The value of the unimproved land is about $150 per acre.**

**The Elder Gravelly Fine Sandy Loam contains some silt, and will retain moisture well enough to produce peaches and almonds without irrigation. With irrigation it will raise almost any deciduous fruit, alfalfa, etc. The value of the unimproved land is about $90 per acre.**

**The Tehama Silt Loam is an upland soil, and, though a fair grain soil, will not produce fruit or alfalfa successfully without irrigation. With irrigation, however, it does fairly well. The value of the unimproved land is about $45 per acre.**

**The Corning Gravelly Loam on this section is underlaid at a depth of from one to two feet by a heavy, impervious clay. It retains moisture very poorly, but will raise grain in favorable years without irrigation. The value of the unimproved land is about $15 per acre.**

*507 Concord Building, Portland, Ore., and 1619 L St., Sacramento, Calif.

can check his work by returning to the same points. The reason for running through on the "forty" lines is that they are usually fenced, which saves running a compass line. Where the agricultural land consists of a creek valley in the mountains half a mile or so wide, the surveyor usually goes back and forth across the valley, returning on each trip to check up. Where the ownerships are by irregular metes and bounds surveys, as they are in many of the old Spanish land grants, no particular system can be followed.

### Methods of Classifying Lands

Other details not previously mentioned are shown on the map, such as the variety of orchard or vineyard, the approximate age, whether in good, fair or poor condition, etc. Annual crops such as grain, corn, hay, sugar beets, etc., are shown to be marked on the finished map in pencil. The cost of clearing all brush or timber land is estimated and the value of all buildings appraised. Size of all irrigation or drainage ditches, condition of roads, levees, etc., depth to water in wells or any other obtainable data of value are given.

The recognition and grading of soils are not very difficult. In all but Shasta County the soils have been named in accordance with the soil surveys of the United States Department of Agriculture. The soils of the various series are given names descriptive of their physical composition, such as Sacramento silt loam, Sacramento fine sandy loam and Sacramento fine sand. Naturally, a river does not deposit three types of soil of entirely uniform physical and chemical composition and with distinct boundaries. Consequently, these soils often merge gradually into each other without any distinct line of change; and with large bodies of soil, for instance, this mixture might be described as sandy silt loam or as fine sandy loam containing a high percentage of silt.

It is here that the grading by numbers comes in, as a sandy area of Sacramento silt loam, being less valuable, would be numbered 2 or even 3; and likewise, as Sacramento fine sandy loam approached Sacramento fine sand in composition, it would be numbered 2 or 3. Often, however, the boundaries are abrupt, being marked by a bank or slough. Different kinds of soils are picked by their physical appearance and not by the analysis of samples, as is sometimes thought. Samples for analysis should be taken from representative areas.

In certain cases the difference in soils occurs beneath the surface, so that borings must be made to find the boundaries. In areas underlain by hard pan, the grading of the soil depends on the depth to hard pan, and also upon whether the chemical composition of the hard pan is such that it will disintegrate under the action of water when broken up by blasting. In most cases changes under the surface are indicated by the appearance of the vegetation. Conditions of drainage, presence of gravel, roughness of the surface, etc., are also considered in the grading.

Alkali is another important consideration in California soils. Surface alkali, which affects shallow-rooted crops, is usually shown by the presence of certain weeds. The variety of these shows approximately the percentage of alkali present. Alkali well under the surface, which will affect alfalfa, fruit and other deep-rooted crops, is determined by electrolytic instruments.

The finished maps have been made on a good quality of white paper by tracing them direct from the field maps. This is done over a piece of plate glass set in a drawing table, with an electric light underneath. Section lines, lot lines, property lines, etc., have been shown in red; soil lines, names and acreages in green; and creeks, ditches, etc., in blue. Orchards and vineyards have been colored pink; alfalfa, green; brush and timber, brown. Areas of permanent crops, roads, ditches, etc., have been in red. Ownerships have been marked with colored pencils. Irregular areas have been figured with a planimeter; regular areas, such as rectangular orchards, by scaling.

The actual cost of the completed maps has ranged from about 3c. an acre for large areas cultivated mainly to grain to a maximum of 6c. an acre in the diversified farming regions of the Sacramento bottoms. The office work has cost almost as much as the fieldwork.

Maps such as described here are valuable for many purposes besides assessment. They would furnish information to prospective buyers of land and would retard to some extent the promotion of fraudulent colonization schemes. They would be of use to many state departments, to the United States Government in the matter of rural credits and to banks in making loans. For the promotion of a large irrigation project, especially one that included small areas already irrigated and successfully farmed to fruit and alfalfa, these maps would be invaluable. They would also afford a means of computing the prospective revenues of a proposed railroad and the future possibilities. Many such projects which have failed of promotion might have succeeded had they been accompanied by maps as complete as those described here.

## Engineers for Oregon Cement Mill

In the article entitled "Electric-Driven Cement Mill of Oregon Portland Cement Co.," published in *Engineering News*, Dec. 21, 1916, p. 1194, the author, D. C. Findlay, said: "The entire civil, electrical and mechanical construction was designed and supervised by the author." This statement does not give proper credit to those connected with some earlier design and construction at the same plant. Mr. Findlay prepared the article as a description of the electrification of the mill only and included the offending sentence with the understanding that its application should be only to that part of the plant.

The plant was started some years ago by the Cement Engineering Co., of which L. D. Gilbert, of Victorville, Calif., was Chief Engineer. After it was well along toward completion another company took charge of the construction, and Mr. Findlay's connection began at that time. The wet process, involving the raw mill and the kiln building, was designed by F. L. Smidth & Co., and the remainder of the engineering work up to the time of Mr. Findlay's connection was under Mr. Gilbert's direction. Mr. Gilbert was also the erection engineer for the earlier owner, and in that capacity had charge of the construction or erection of the plant trackage, crushing machinery and most of the storage bins and of the raw mill. Under Mr. Findlay's direction the mill was completed and the entire electrification, elevating and conveying installation and the rotary-kiln installation were placed, utilizing a great deal of the earlier designs and of the Smidth equipment.

# Financing Water-Supply and Sewerage Connections and Plumbing

By R. A. Butler† and F. C. Jordan‡

When Moses, who appears to have been the first sanitarian of whom we have any authentic record, laid down a code for living and being clean, he fitted his laws to both the rich and the poor. He said that if the unclean person was too poor to sacrifice a sheep or a goat on the altar, as a part of the purging process, he might sacrifice a fowl. A sacrifice was necessary to cleanliness then, just as in the present day. But, unlike the present day, the sacrifice might be of two values—one for the rich and one for the poor.

In this day, however, there are not two prices for the water service necessary to the sanitary disposal of water. Nor is there any considerable deviation in the price of bath tubs and plumbing. Each demands sacrifice, easy for the rich and prohibitively difficult for the poor.

The inability of many to contribute to the sanitary progress of all should not be confused with ignorance or lack of interest in proper sanitation. We may not agree that all persons would rather be clean than unclean, but we must confess that every individual values his health; and the great majority value the health of the community as a whole.

The little home, with its well water-supply, its lack of sewers and its open vaults, must give way to water service, sanitary sewers and sanitary closets. Some way must be found to finance these improvements without throwing too great a burden on small property owners.

## Water and Sewer Facilities Made Easy

Have not the distributors of automobiles pointed the way for the distribution of sanitation? Today, if you wish, you may go to any dealer in automobiles and purchase a car by the payment in cash of half or less of the list price. A funding company will supply the rest of the purchase price and so arrange the deferred payments that you may make one a month for a reasonable period. The automobile is delivered to you under a lease, and the title remains with the funding company until the last payment is made. Insurance, interest and brokerage make this an attractive investment from the standpoint of the funding company, and the everlasting longing of the American purchaser for more luxury is the incentive that makes the business possible.

Why not apply the same principle to sanitation? Why not make it possible for the man who owns a small property to have sanitary plumbing installed in his home and the cost thereof extended over a reasonable period?

Electric light companies are wiring homes and gas companies are installing ranges on the installment plan. They have the sales and the collection systems already in operation, and the addition of appliance accounts is simple and involves little cost.

This same method of financing can and will be applied to water service and modern sanitary improvements in the near future. It is a problem that confronts water companies all over the country, and it is a solution that means more services on their mains, the use of more water and the improvement of the health of whole communities.

The water utility that undertakes plumbing as a side issue, for the purpose of intensifying its patronage, will encounter difficulties in the way of criticism. It may be denounced as a grasping corporation seeking to establish a trust in the plumbing business. But the fact remains that because of its buying power, its credit, and the ability to wait for its profit and take it in increased water consumption, it will be able to give to the property owner more satisfactory plumbing at less cost than it can now be obtained.

In Indianapolis there is an outlet from the mains of the water company for every 7.5 persons in the city. The average size of a family is five. It follows that the business of the water company is 33⅓% less than it might be. This one-third represents the field of prospects, and any merchandising expert will say that one-third of the whole of a city's population is a desirable field to cultivate.

With one-third the city as the field there is necessary to the development of business, capital sufficient to equip the possible user of water for its enjoyment. The installation desired in the class of homes in the city that now have no water service has been estimated at a physical cost of from $100 to $250, according to size and location. Taking the lowest figures as a basis, interest at 6% for two years and a brokerage charge of 6% could be added, and the installations made at a partial payment cost of $4.92 a month for 24 months. To this should be added the cost of water, not exceeding $1 a month, making in all a charge against the property of $5.92 a month, or approximately 19.7c. a day. This should prove a fairly attractive proposition for the man with a small property whose concern is a safe water-supply, such as is furnished by water utilities.

## Leasing Plumbing Fixtures

Turning now to sewerage facilities, it may be noted first of all that the cost of plumbing fixtures in a modern home is not the major item of expense, but the fixtures are the necessary item to the enjoyment of sanitation. It is urged by plumbers and others that no property owner who has once had plumbing fixtures installed can afford to have them removed from a house. The removal is attended by such wreckage that the property would depreciate in value to a point far in excess of the cost of the fixtures and the labor necessary to sanitary plumbing. It is argued that an owner who has profited by better rentals or greater conveniences would exhaust every resource rather than suffer the removal of plumbing fixtures which have only recently been installed. Consequently, those who have investigated the credit problem maintain that a lease drawn to cover the fixtures installed in the house and affording legal right to enter and remove these fixtures in event of noncompliance with the terms of these leases would in practically all instances be sufficient protection for capital, no matter how timid it might be.

## Funding Company Proposition

Organization and operation of the funding company is possible at a very small overhead cost. The amount of capital actually necessary is dependent on the size of the field, but a consideration not to be overlooked is the fact that each month brings part of the capital

*Condensed from a paper read before the Indiana Sanitary and Water-Supply Association, February, 1917.

†The Jenne-Butler Co., Indianapolis, Ind.

‡Secretary, Indianapolis Water Co., Indianapolis, Ind.

back for reinvestment, and with each monthly payment the individual account becomes more secure.

Operating expenses of the funding company would consist of three branches: Promotion of business, investigation of risks and collection. The expenditure necessary for the promotion of business will depend on the method of operation finally adopted.

In the automobile business it has been found more desirable to have the funding company separate from the sales agency, in name at least. Perhaps this would be more advisable in sanitary funding. Certain it is, that if the funding company were holding out to each plumber an opportunity to do work and collect his money immediately, even though the employer is not in a position to pay him cash, every plumber in the community would become an enthusiatic salesman, and the cost of sales would be greatly reduced for the funding company.

The ideal situation seems to involve the organization of a company with sufficient capital to be able to say to the property owner: "Hire any plumber you choose and select any fixtures you desire. We will pay the entire cost and give you two years in which to pay us."

Then, with the plumbers of a city the enthusiastic boosters of the funding company, the examination of the risks is the next important operating detail. It has been estimated that this work can be accomplished at a minimum fee of $5 a risk. The burden of showing title to the property is to be thrown on the applicant for a contract, and extensive investigation is not necessary. A manager of ordinary intelligence would be capable of judging the advisability of the contract, and a single inspection of the property should be sufficient to satisfy him. The time element is not important, and his work could be so distributed as to make it least expensive.

For convenience of collection, the water rental and the partial payment should be payable at the same place, the lessee being billed for the total, and the utility holding the funding company being responsible for the water rental. A simple card system of bookkeeping and a stenographer supplied with suitable letter forms for prodding the delinquents should accomplish the collections without great expense.

### Enlisting the Small Property Owner

Whenever it is possible for the small property owner to improve his property without shouldering a hardship in the form of a big initial expenditure, it will be easier to insist on sanitary improvements. Laws designed to wipe out open vaults and unsafe wells will not be assailable on the ground that they are confiscatory. Property owners will benefit by increased value of their holdings. Renters will find properties more desirable. Water utilities will cut down their fixed charges as they increase the number of their patrons. Improved sanitation will bring about better health, and there will be far more individual effort toward community health.

**A Combined Technical Association and Labor Union** is the Civil Engineers and Surveyors Assistants Association, of Chicago, which is affiliated with the American Federation of Labor. A circular issued by the association states that although these men are technically trained and have considerable capital invested in their educational equipment, they often receive less pay than the laborers working under them. The assistants have organized therefore in order to secure compensation more in accord with their responsibility and training. The secretary is Le Roy Brown, 1435 North Oakley Boulevard, Chicago.

# Suggestions for Selecting and Testing Drill Steel

By Frank H. Kaiser*

Mining with rock drills has progressed to a point where the actual efficiency of the drilling operation depends more on the drill steel than ever before. In order that the steel can meet these conditions, one must be able to obtain a uniform quality of steel and be able to subject the steel to the proper treatment. There must be means of doing this from day to day. As a suggestion for meeting these conditions the facts in this article are presented.

Although the chemical qualities of steel have a great influence, the analyses of drill steel are practically standardized. A chemical laboratory would be a good asset, but it is not essential for this work. When the proper heat-treatment has been given to the steel—assuming the steel to have the chemical properties as specified for standard drill steel—and the treated steel is either too soft or gives exceptional service, a sample of it could be sent to a commercial laboratory for chemical analysis.

Drill steels are made by both the openhearth and crucible methods. The crucible-made are lower in phosphorus and sulphur as a rule, while the openhearth is lower in silicon. For each grade in either make, the carbon content will vary according to the size of the steel. In general the average analysis of a drill steel would show:

| | % | | % |
|---|---|---|---|
| Manganese | 0.25 to 0.40. | Some makes as low as | 0.15 |
| Phosphorus | 0.01 to 0.025. | Some makes as high as | 0.04 |
| Sulphur | 0.015 to 0.025. | Some makes as high as | 0.04 |
| Silicon | 0.10 to 0.20. | Some makes lower | |
| Hardness (as received) | 40 to 50 scleroscope or 225 to 300 Brinell | | |

The carbon content will vary as follows, as to shape, size and make:

| | % Carbon |
|---|---|
| American-made octagon | 0.80 to 1.00 |
| American-made cruciform | 0.80 to 0.95 |
| American-made hexagon and round hollow | 0.70 to 0.85 |
| American-made solid and hollow spiral | 0.70 to 0.85 |
| F.J.A.B. No. 7 | 0.65 to 0.80 |
| F.J.A.B. No. 10 | 0.90 to 1.05 |

It is advisable in selecting a drill steel that either a steel company or a drill manufacturer be consulted, as their experience fits them to suggest the best steel for the conditions. Request the steel company to give the critical range of the steel and the proper forging, annealing and hardening temperatures.

Each bar of drill steel as received should have a 3- or 4-in. test piece cut off and the piece and bar numbered. In this way a record can be kept of when the bar was received, from whom and the service given. Determine the Brinell hardness on the cut end of the test piece and then subject the piece to a simple forging operation, heating to the recommended forging temperature. Anneal the piece as recommended and then harden, using the recommended temperature and quenching medium. If the steels as used are drawn or tempered, the test piece should be heated to the same drawing temperature. Determine the Brinell hardness on this properly treated test piece, then break it and examine the fracture, noting the grain. If the fracture shows a seam or pipe, the bar should be rejected.

Each drill steel made should bear the same number as the bar from which it is made, and a record should be kept of the service of the drill steel. In this way a

*Metallurgist, Sullivan Machinery Co., Claremont, N. H.

record will be had of the Brinell hardness of the steel as received, the complete heat-treatment, the hardness of the heat-treated steel and the service of the steel in the mine. After a hundred or so tests have been made, some of the high, medium and low Brinell test bars and those giving the best service can be analyzed. In this way a standard specification can be determined for the drill steel best suited to meet the conditions of the mine, giving the desired carbon range (10 points) and the Brinell hardness range.

The essential equipment consists of the following: Brinell testing machine; furnace for heating the steel, equipped with pyrometer; quenching tank; tempering or drawing bath; means of forging. Except the testing machine, this equipment can be found in the blacksmith shop.

### Hints as to Apparatus

Gas or oil-fired furnaces of the muffle or semi-muffle type give the best results and are easily manipulated so that a constant temperature can be maintained. Furnaces should be adapted to meet the conditions.

Pyrometers are essential. Base-metal couples should be used either with galvanometer or potentiometer. Use equipments that automatically take care of the cold junction. Both the Wilson-Maculen base-metal equipment and the Leeds & Northrup potentiometer equipment have proved serviceable. Adapt the pyrometer equipment to the conditions.

Place the base-metal couple in an X or XX iron pipe plugged or welded shut at one end, then place this in the chamber of the furnace as near to the drill steel as convenient. The indicating instrument should be somewhat away from the furnace, so placed as to be free from vibration and excessive changes in temperature.

The pyrometers should be checked weekly at least. One base-metal couple can be kept as a standard and compared with the one in service. When the regular one shows too great a variable error, use the standard as regular and purchase a new couple to use as standard. The indicating instrument should be sent away periodically to be tested and regulated. Complete information and instructions should be obtained from the manufacturers at the time of purchase.

It is not essential to have an equipment for determining the critical range. Obtain this range from the steel maker. The hardening heat is higher than the critical range and depends on the shape and size.

### Hints as to Treatment

The following table will show the approximate critical ranges and hardening temperatures of steel relative to the carbon content:

| Carbon Content, % | Critical Range, F. | Hardening Temperature, F. |
|---|---|---|
| 0.60 | 1,340 to 1,380° | 1,400 to 1,460° |
| 0.70 | 1,340 to 1,375° | 1,400 to 1,450° |
| 0.80 | 1,340 to 1,365° | 1,390 to 1,450° |
| 0.90 | 1,340 to 1,360° | 1,375 to 1,450° |
| 1.00 | 1,340 to 1,360° | 1,375 to 1,450° |
| 1.10 | 1,340 to 1,360° | 1,375 to 1,430° |

The forging temperature for drill steels should be from 1550 to 1600° F. Do not continue the forging operation after the steel fades from a red color, as forging a steel cold or below its critical range distorts the structure and tends to produce brittleness. Reheat the steel, if necessary, to finish the forging operation.

In annealing, heat the steel just above the critical range and cool slowly. In hardening, if the steel is rapidly heated, it should be held just long enough to heat thoroughly. Uneven heating results in a soft center. On the other hand, the steel should neither be held too long at the hardening temperature nor soaked, as such treatment opens the grain or enlarges the crystals, tending to brittleness.

The quenching bath should be large and deep. Clean water is a suitable quenching medium, but for uniform results it should be kept at 60 to 80° F. After the steel is quenched, it is in its hardest condition, with a tendency to be brittle; accordingly, it will not well resist shock. To obviate this, it is well to draw the temper, thus sacrificing a small amount of the original hardness for a like gain in toughness. The temperature to which the steel should be drawn will depend on the condition of the rock. This must be determined by experimenting. The drawing temperature will vary from 350 to 600° F. Use a heavy or 600° fire-test oil for the drawing medium, reading the temperature with a thermometer. The "Tycos" armored thermometers, of the Taylor Instrument Co., Rochester, N. Y., are suitable.

In treating the shank end of the steel, after forging and annealing, heat to the proper hardening temperature and quench in oil. The oil tank should be large and the oil kept at a uniform temperature by circulation through a coil surrounded by water or by circulating the water through a coil around the inside of the oil tank. No. 2 soluble quenching oil, made by E. F. Houghton & Co., Philadelphia, Penn., is suitable. When the steel has reached the temperature indicated by the pyrometer, the color of the heated steel will be the same as that of the iron pipe in which the base-metal couple is in direct contact with plugged end inserted in the furnace.

In conclusion I desire to urge coöperation with the steelmaker in all drill-steel troubles, as I believe the steelmaker is as anxious to give satisfaction as the user is to obtain it.

## Liquid Chlorine Proves Superior to Hypochlorite

Liquid chlorine cost much less and effected more bacterial reduction than hypochlorite and was in other respects more satisfactory on one installation, according to a paper by M. S. Dutton, of the Central Illinois Public Service, Lawrenceville, Ill., before the Illinois Section of the American Water-Works Association, Mar. 13-14.

With hypochlorite at 7c. and liquid chlorine at 20c. the average cost of hypochlorite treatment for January was $1.07, compared with only $0.28 per 1,000,000 gal. for liquid chlorine.

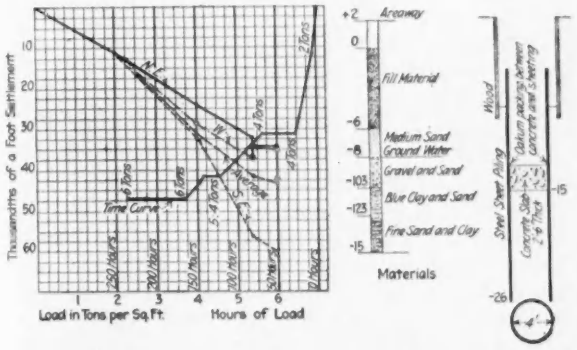
The average reduction in bacteria count of daily plates made on nutrient agar incubated at 37° C. for 24 hours, was as follows: In January when hypochlorite was used the average raw-water count was 6300 and the filtered-water count was 15. In June, when liquid chlorine was used, the average raw-water count was 7980 and the filtered-water count was 11. In B. Coli tests, the raw water shows 100% for each month, while the filtered water shows 1.6% in January and 0.0% in June. These results were obtained by means of 1 c.c. samples in all cases. Also note that while hypochlorite was used 0.46 p.p.m. of available chlorine was applied and while using liquid chlorine 0.22 p.p.m. of chlorine was applied.

# Notes from Field and Office

**Bearing test on wet sand confined by steel sheet piling—Siphoning water over a 95-ft. barrier—Detail index in a structural engineer's office—Unusual operation at an Ohio River dam**

## Bearing Test on Confined Wet Sand

A concrete slab-and-girder mat, with the wet treacherous sand underneath confined by a ring of interlocking steel sheet piling, supports the new boiler house and coal-storage plant of the New York Steam Co., at Burling Slip and Water St., in downtown New York City. The load of the boiler room averages 2.6 tons per sq.ft. of the entire foundation; for the coal-plant mat the load is 5.4 tons. Before the Building Department would permit such a foundation to be laid, it had to be convinced by tests of the safety of the method. The sketch shows how the loading test was made and gives the settlement by curves.




LOADING TEST FOR UNUSUAL FOUNDATION

The test arrangement is really a model of the foundation proposed. A steel sheet-pile box was driven to a depth of 26 ft. below curb and the material inside excavated to a depth of 15 ft. A concrete slab 2½ ft. thick was placed on the sand bottom below groundwater. The slab was loaded with pig iron to give a maximum load of 6 tons per sq.ft., and readings were taken on the four corners. The greatest settlement after 237 hours was 0.061 ft., the average settlement for this period being 0.047 ft. The time curve shows that there was no settlement between load applications.

After this satisfactory test, the foundation mat, designed by Daniel E. Moran, consulting engineer, was constructed by The Foundation Co.

## Mechanical Siphon Forces Water Over 95-Ft. Summit

BY J. W. SWAREN*

The writer recently inspected a mechanical siphon in western Idaho, consisting of a motor-driven centrifugal pump and a generator driven by a Pelton waterwheel, which is worthy of brief record.

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In 1914 the increasing demands on the Lewiston-Sweetwater Irrigation Co., of Lewiston, Idaho, made it necessary to divert additional water into Sweetwater Creek, on which the company had depended. It was decided that Lake Waha was the most economical source; this body had been formed by a landslide and had no visible outlet, evaporation and seepage balancing the inflow. It was decided that a daily draft of 10 sec.-ft. could be taken through the irrigation season.

Tunnel schemes of getting the water past a 95-ft. barrier were abandoned in favor of a mechanical siphon. A centrifugal pump having a capacity of 10 sec.-ft. against a head of 145 ft., when driven at 1170 r.p.m., was installed near the water's edge. It is direct-connected and mounted on the same sub-base with a 250-hp. 2300-volt wound-rotor-type induction motor. This unit is mounted on concrete piers; two groups of these are provided to accommodate the lower level of the lake as the season advances. In the spring of 1917 the pumping unit will be mounted on a car running on a track extending into the lake, and the car will be raised or lowered by a windlass.

A 20-in. flanged-joint suction line, 120 ft. long, made of ¼-in. riveted plates, extends into the lake. The elec-

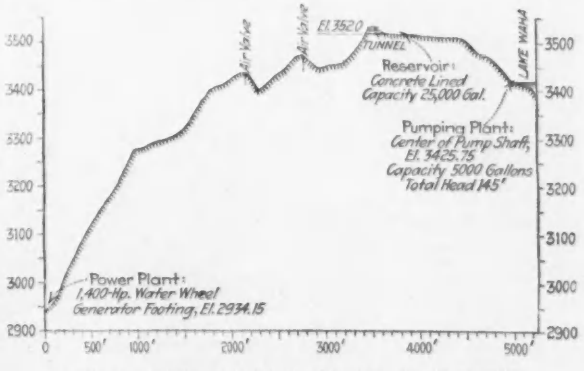


FIG. 1. PROFILE OF LAKE WAHA SIPHON

tric control apparatus is housed in a separate building. This includes a starting-contactor panel, which prevents over-acceleration of the motor.

A 30-hp. gas engine is installed for driving a vacuum priming pump, and a 4-in. centrifugal is used to fill the discharge pipe, the reservoir at the summit and the penstock. This is necessary before the hydro-electric pumping combination can be started.

A 20-in. 16-gage slip-joint line 1650 ft. long leads from the pump to a balancing reservoir near the canyon rim and at the summit of the hydraulic system. At this point a reinforced-concrete reservoir 8 ft. deep and 50 ft. long has been built. Its bottom is at El. 3520. A float gage actuates the contacts of a circuit formed by

utilizing the telephone line connecting the power house and the pumping plant, promptly sounding an alarm if the level in the reservoir changes 6 in. Normal level is just below the spillway; and should it drop 5 ft., air will be drawn into the penstock. The reservoir eliminates trapping of air at the summit of the pipe system, and shutdowns are made in the irrigation season only to change the pump setting or for inspections.

At El. 3520 a 5 x 3½-ft. tunnel 51 ft. long pierces the canyon wall. The penstock, laid in this tunnel, leads directly from the reservoir. It is 15 in. in diameter, with a total length of 3484 ft. Of it 1890 ft. is 16-gage slip-joint; 358 ft. is 14-gage slip-joint; 427 ft. is 12-gage slip-joint; 332 ft. is 10-gage flanged-joint; 323 ft. is 7-gage flanged-joint; and 144 ft. is ¼-in. flanged-joint. Air valves are set at two summits, both of which, however, are below the hydraulic gradient of the normal operating conditions. The bottom is anchored by a concrete footing. A taper nipple 10 ft. long reduces to 10 in. and connects to a Y, one branch of which supplies water for the generating unit, connecting to a rising-spindle gate valve inside the power house.

FIG. 2. POWER HOUSE AND PUMPING PLANT, WAHA SIPHON

The power house is a frame building 30 x 40 ft. Its floor is at El. 2934. It houses a single generating unit consisting of a 200-kv.-a. three-phase 2300-volt generator, direct-connected to a Pelton-Doble tangential wheel, developing a maximum of 400 hp. The static head is 590 ft. The water requirements of the waterwheel are much less than the 10 sec.-ft. supplied by the pump.

A bypass valve is connected on the second branch of the terminal Y. The waterwheel has a hand-operated needle nozzle; speed control is obtained by a stream-deflector actuated by a self-contained oil-pressure governor. A tailrace, excavated from the soil and unlined, conducts the water from the generating unit, and from the bypass, to a branch of Sweetwater Creek about 200 yd. from the power house. No water-measuring devices are installed in the tailrace. Several attempts have been made to use timber weirs, but the soil is extremely permeable, and these were quickly undercut and carried away.

A belted exciter is driven from the mainshaft of the unit. As the generator develops the full-line voltage, the electrical equipment is simple, consisting of a single automatic oil circuit-breaker, a voltmeter and an ammeter, and exciter and field control mounted on a single-panel switchboard.

The siphon is started, after priming pump and pipes with the gas-engine units as already noted. First, the waterwheel and generator are started; the pump attendant then throws the pump motor on the line as soon as he is notified by telephone. The 25,000-gal. reservoir at the summit will run the generator unit for about 20 min., driving the pump.

This siphon, as well as the entire system of the Lewiston-Sweetwater company, was developed by H. L. Powers, President and General Manager. The data for these paragraphs were obtained from Mr. Powers and R. H. Mann, engineer of the company, by the writer while inspecting the installation for the Pelton Water Wheel Co., contractor for the waterwheel equipment.

## Index of Details for a Structural Engineer's Office

By Albert M. Wolf*

Well executed and consistent plans are the prime indication of a good design in all classes of structures; especially in building work, which involves a great many different types for the great variety of uses. This makes standardization of details and design somewhat more difficult than for the superstructures of highway and railroad bridges, but unless standardization is kept in mind constantly, the cost of making the design is quite likely to be so high as to show little profit; and at the same time the resulting structure may be more costly to the owner than if the reverse were true.

A large structural-engineering office—one employing a large force of draftsmen and designers, and carrying on work simultaneously on several large buildings—must of necessity have a good set of office standards for the guidance of the men and as an aid to the chief draftsman or engineer in obtaining uniform practice on all jobs of the same type, without necessitating his spending the greater part of his time giving instructions and personal supervision to each and every man or squad.

The office standards for concrete building design should include tables and diagrams for the design of reinforced-concrete slabs and beams (such as values of $K = \frac{M}{bd^2}$) for various combinations of unit stresses; areas and weights of steel bars; data on web reinforcement of beams; reinforcement of spandrel girders; diagrams and tables for the design and detail of reinforced-concrete columns and footings and for steel columns incased in

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concrete; tables and details showing amount and method of reinforcing concrete stairs, and standard sheets showing the arrangement of lettering, dimensions, details, etc., on the floor plans. For steel building design the standards may include properties of various types of columns; connection details; bracket details; cast-iron bases; typical details of spandrel beams, crane girders, steel stairs, steel stacks, tank floors, towers, etc.

In order that original and special details developed—which would not ordinarily be indexed in the general job file or included in the standards—may be readily found, a card index of various details of completed designs in the office files, which are likely to be used on other work or referred to at various times, should be maintained. With such a file a new man in the organization can at once acquaint himself with methods of detailing certain portions of a standard or special building without a lengthy explanation on the part of the chief draftsman, thus saving much valuable time and increasing materially the speed with which the plans can be completed.

## Sheet Pile Cutoff Wall Allows Work Close to Cofferdam

By Charles F. Nimmo*

A box cofferdam 20 ft. wide was built on the lower side of the pass of dam 33, Ohio River, at Maysville, Ky. It extends 18 ft. above low water and is backed on both sides by river-run sand and gravel. The bottom of the pass is 1 ft. below, while the bottom of the crib (see sketch) is approximately 10 ft. below, the original river bed; so that if the construction work were brought too close, the outer arm of the cofferdam would be weakened. Especially would this occur when the river is at medium to high stage. In order to get the fastest progress under such a condition of high water, the cofferdam was safeguarded by the following device:

A line of steel sheet piles was driven around the outer end of the pass, as shown in Fig. 1. The crib for pro-

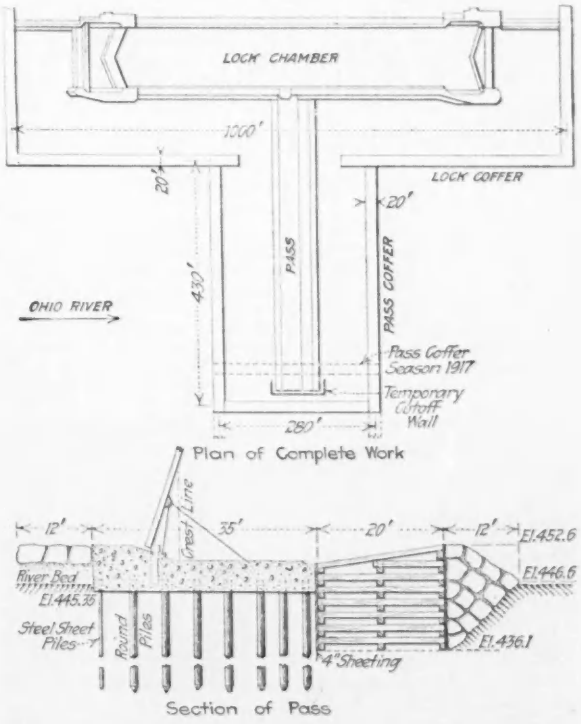



FIG. 1. LAYOUT OF WORK AT DAM 33, OHIO RIVER

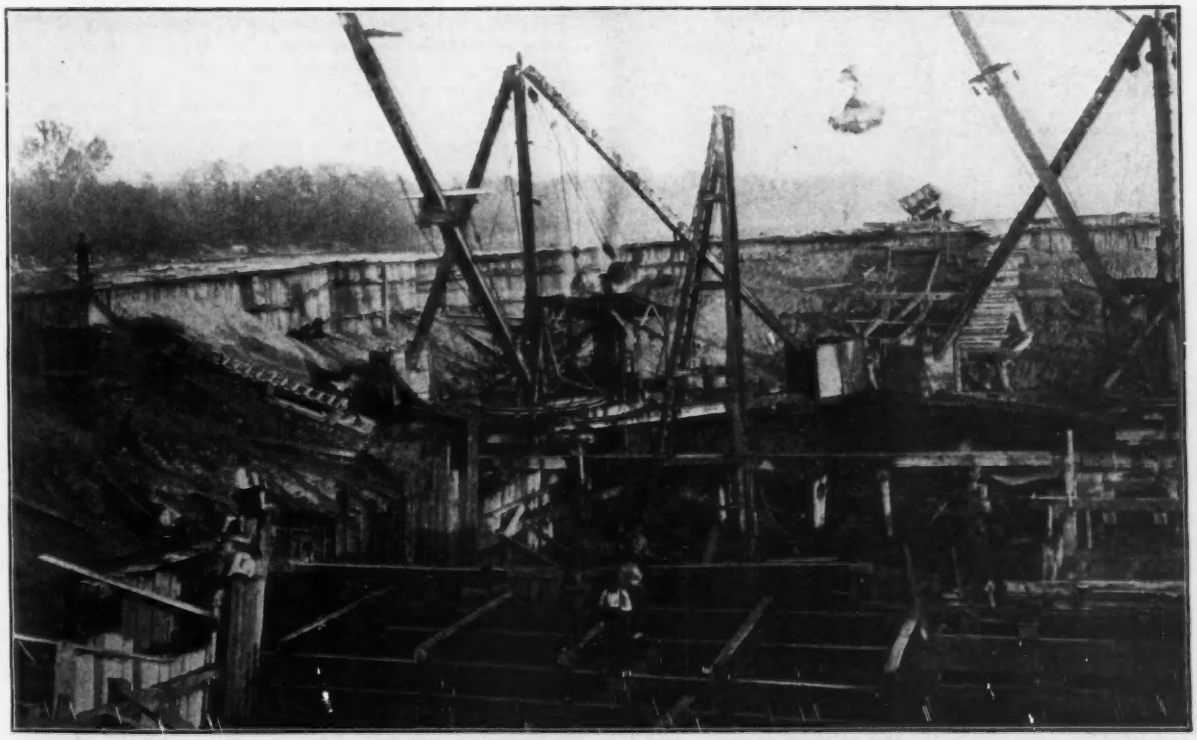


FIG. 2. EXCAVATING CRIB INSIDE LINE OF SHEET PILES

*United States Engineer Office, Maysville, Ky.

tecting the concrete pass was assembled on the line and lowered to place by clamshells on traveling derricks, excavating within the crib. Piles were driven under the pass, forms were set, and the concrete was poured.

This cutoff wall enabled the contractor to complete an additional 52 lin.ft. of pass and 76 lin.ft. of crib with very slight increase in cost, as the piling is suitable for next season's work. The cofferdam area thus protected from flood was 460,000 sq.ft. The lock and dam are being built by the Bates & Rogers Construction Co. for the United States Government. F. M. Morgan is Junior Engineer for the Government.

## FINE AGGREGATE

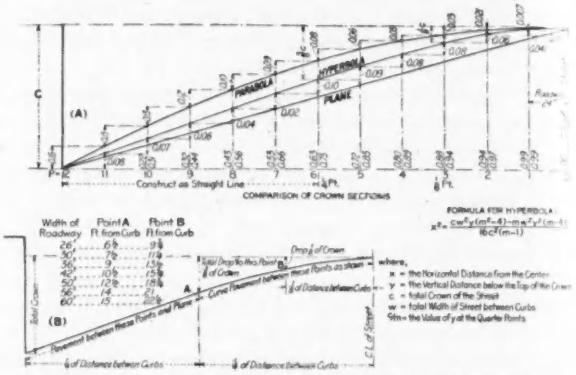
**Heavy Truck Breaks Through Old Bridge**—With the adjoining picture, a correspondent sends the following brief account of facts: "A 5-ton truck loaded with cement to capacity started across a bridge over an abandoned canal, the bed of which is now dry. The floor timbers of the bridge broke, and the truck fell to the bed of the canal. This was a paving contractor's truck." The accident occurred at Cohoes, N. Y., last summer. It illustrates the importance of the warnings

BRIDGE FLOOR FAILED TO HOLD UP LOADED CEMENT TRUCK

repeatedly given in the columns of "Engineering News" that the heavy loads of motor trucks are a menace to all but the most amply designed highway bridges. Poor maintenance, especially of timber parts, is a factor in increasing the danger of excessive loads.

**Hyperbolic Curve for Pavement Cross-Section**—The 40-ft. concrete pavements constructed in 1916 at Depew, N. Y., were given a cross-section whose middle half is hyperbolic, while the outer quarters are straight lines tangent to the hyperbola. The illustration shows the elements of this cross-section and its comparison with a cross-section made up of straight slopes intersecting at a central ridge, and with a parabolic cross-section of the same crown. For roadways with no car tracks a hyperbolic cross-section was used in which m = 8/3; that is, ⅜ of the total crown is the drop at the ¼ points. The equation of this hyperbola was reduced to a form for determining the vertical drop at any $\frac{1}{12}$ point of the roadway width.

On streets with car tracks, where the distance from the rail to the gutter is 12 ft. or less, block pavements are laid on a plane surface with a uniform fall from track to curb varying from less than ¼ to nearly ⅜ in. to the foot, according to the kind of pavement used and the grade of the street. On other streets, where the distance is between 12 and 22 ft., the plane


(A)
PARABOLA
HYPERBOLA
PLANE
Construct as Straight Line
COMPARISON OF CROWN SECTIONS
FORMULA FOR HYPERBOLA
Width of Roadway
Point A Ft. from Curb
Point B Ft. from Curb
(B)
Pavement between these Points and Plane
Curved Pavement between these Points as Sheet
where,
x = the Horizontal Distance from the Center
y = the Vertical Distance below the Top of the Crown
c = total Crown of the Street
w = total Width of Street between Curbs
ym = the Value of y at the Quarter Points

HYPERBOLIC CURVE FOR PAVEMENT CROSS-SECTION

is varied slightly by using 7/3 for the value of m in the formula, deducting of course the space occupied by the rails from the width between curbs for w. The formula gives then a drop of practically ⅛ of the crown at the ⅛ point and $\frac{3}{7}$ at the ¼ point. For greater widths of pavement on car-line streets the regular ⅜ quarter-point formula should be used.

In chart A in the accompanying figure the portion of the total crown in each $\frac{1}{12}$ unit of the distance from the gutter to the center of the roadway is shown by figures along each of the curbs, and the total accumulated proportion of the total crown rise above the gutter for each cross-section by twelfths along the base line. It will be noticed that on the hyperbolic cross-section the rise from the gutter to the point half-way to the center is almost exactly a straight line, the variation at the extreme end being less than 1% of the total crown. In practice this portion of the pavement would therefore be constructed as a straight line. From the ¼ point to the ⅛ point the rise is almost exactly two-eighths of the crown, the remaining one-eighth being distributed in the center eighth section.—Charles A. Alderman, Buffalo, N. Y.

**Cordwood Grillages** are under the footings of a number of old buildings in lower New York City An excellent example of this type of bearing or grillage was uncovered during excavation for the new Bowling Green exchange of the New York Telephone Co., at Broad and Pearl Sts. These mats of saplings were found just below water line and probably date prior to 1800. On the mat, 3-in. planks 4 or 5 ft. long were laid at right angles to the axis of the wall, and on these two 12 x 12 stringers were placed, to support the masonry footings.

CORDWOOD GRILLAGE BUILT ABOUT 1780

# Editorials

## George Henry Frost

This number of *Engineering News* would be incomplete without a word in this place of personal regard for the man who founded this journal and who has passed from this life within the past week. On another page is told the story of Mr. Frost's life. We wish to emphasize here the great ambition which dominated him to render a large service to the civil engineering profession.

Forty-two years ago, when he was a struggling young land surveyor in Chicago, he dared to risk his slender means in starting a journal which should give to engineers the sort of information of which he himself had often felt the need. It was a long, hard, uphill struggle for many years; but what encouraged Mr. Frost to persevere was the appreciation and friendship of those who at that day stood in the forefront of the engineering profession. As the years passed on and he relinquished active work in the direction of his journal to others, he continued nevertheless his interest in the men of his profession. It was always a source of great pleasure to him to meet or to hear from some of the oldtime subscribers who had been helped by the work done in those early years. It was his greatest pride in later years to realize that his journal had become a powerful means of serving the engineering profession.

Mr. Frost was a good citizen, interested in and willing to aid in public affairs, a man of blameless honor and integrity, of genial personality, with broad human sympathies and a high appreciation of the best things in life. We whose privilege it was to be associated with him in the work upon this journal believe that we are speaking for a great body of engineers, those of the present day as well as those who have gone before, in paying tribute to his memory.

THE EDITORS.

## Water and Sewer Facilities for All

Every city and town of any size now has a public water-supply, and most have at least a start toward a public sewerage system. Notwithstanding this, a large percentage of the families in these cities have no running water in their houses, no bathtubs and water closets or, having the two last named, lack sewer connections and are dependent on cesspools for waste disposal. Where live boards of health exist, they bring constant pressure to compel the abandonment of privies, cesspools and polluted wells and are as constantly resisted by property owners who declare their financial inability to make water and sewer connections and install modern plumbing.

In thousands of cases the plea of financial inability is well founded; and in other thousands of instances, although there may not be an absolute financial bar, the cost of needed house sanitary improvements would be a trying addition to existing financial overburdens. And yet public health and general welfare demand that these improvements be made.

How to meet this demand without undue resistance and burden is a question that has been discussed by boards of health and other local authorities again and again. That it has not often come before the health and engineering society conventions is perhaps surprising and gives all the more interest to a recent suggestive paper by R. A. Butler and F. C. Jordan, abstracted elsewhere in this issue. Their proposal is the annual-payment plan of meeting the first cost of water and sewer connections and plumbing fixtures, such as been followed with marked success by the gas companies for years past. Combined with this, the authors suggest a funding company in each city to finance the proposition, similar to the funding companies that have been such a factor in the automobile sales industry.

The proposed plan, which is presented with some illustrative detail, deserves thoughtful consideration. Alongside with it there should also be considered the alternative of having the city rather than a funding company finance the scheme. Those who have had to deal with the municipal side of abolishing privies, cesspools and polluted wells know that the people resent any action that savors to them of playing into the hands of a water company or plumbing concern or loan house. Certainly, the ideal would be for the city to give the poor man, for whom the authors of the paper are pleading, the benefit of the low prices at which the city can purchase material and the low interest notes at which it can borrow money. Obstacles to the attainment of this ideal are municipal inefficiency and the objections of local plumbers and contractors. It should be left to each community to choose between private enterprise and profit and municipal financing and control of some such general plan as that proposed to make modern house sanitation available to the poor.

## San Francisco Water-Rate War

Water rates at San Francisco have been a bone of contention for so long that city officials, the Spring Valley Water Co., the citizens and above all the daily press would feel that something had dropped out of their lives if the controversy were to end suddenly. There is little immediate likelihood of such a happening, for although the rates for each of the seven years ending with 1914-15 are now out of the trial court and in the hands of a referee, the present and future rates, at least for water used through meters, are before the State Railroad Commission.

To add spice to the present rate case, account books and memoranda covering a number of the early years of the company are said to have come to light through the agency of the San Francisco *Chronicle*. These books, the *Chronicle* says, the company ordered burned, and supposed they were burned. It is alleged that the recovered books and memoranda will show that the Supervisors were justified in establishing such rates as they did for the seven disputed years, and will also show that

the meter rate of 28¾c. per 100 cu.ft. which the company has recently been trying to collect is altogether too high.

The folly of the old system of annual rate making by the Board of Supervisors (City Council) is emphasized by the litigation over the 1908-9 to 1914-15 rates which has impounded alleged excessive rates of $2,063,000 during that period, which has been banked at 2% interest, compounded monthly. The interest charges now amount to $215,000.

Those who argue for local rather than state control over utility rates may well heed the experience of San Francisco, although it would be unfair to debit all the controversy at San Francisco to local control. In the earlier years, at least, it was not real public control of rates that gave rise to much of the controversy. In fact, it is alleged that the control was quite the other way; that the water company and other utilities controlled the city authorities—to the personal profit of the latter and the expense of utility patrons and taxpayers.

## Unprecedented Shipbuilding Conditions

No industry in the United States is working under greater pressure than the shipbuilding industry. For more than a year past, the constantly increasing demand for vessels to carry ocean freight, and the scarcity of vessels to meet the demand has brought greater and greater pressure upon every shipbuilding yard in the United States.

Now comes in addition to the economic pressure the realization that the most effective thing for national defense that the United States can do at the present time is to build vessels as rapidly as possible to keep up the movement of goods to Europe.

It is pretty well known that one main reason why Great Britain has so long held the lead of all other nations in the shipbuilding business is that she has been able to build freight steamers of standard types by the dozen instead of singly, and thereby greatly reduce the cost.

In the present emergency in this country it is generally recognized that the best plan for quickly producing a large fleet of merchant vessels is to build ships of the simplest possible construction according to standard plans, made with a view to utilizing available machinery and materials. This plan has already been put into practical execution. The hull of the modern freight steamer is practically a rectangular steel box except at the bow and stern. Probably more than nine-tenths of the work on such a vessel can be done with the methods and machinery of the ordinary bridge shop. Accordingly, one of the largest bridge manufacturing concerns in the United States has for some time been actively engaged in the construction of hulls for ocean vessels. It builds the entire hull with its ordinary force of employees and machines, with the exception of the bow and stern, which are left for completion by a regular shipyard.

The scarcity and high price of steel ship plates, which are now quoted as high as $150 per ton for 1918 delivery, has brought about an astonishing revival of wooden shipbuilding. In the Puget Sound district, that paradise of cheap and excellent lumber, the activity in wooden shipbuilding is limited only by the men available for the work. There are 68 wooden vessels now building in Pacific Coast yards with a combined capacity of 88,563 tons. Across the border in Canada work is equally active; 25 vessels are being built at Vancouver. To facilitate similar work on the Atlantic Coast, the Grand Trunk Pacific is hauling lumber clear across the continent on a passenger schedule. In Yarmouth, Nova Scotia, 35 wooden vessels are building.

The Federal Shipping Board has recently undertaken an extensive campaign to secure the building at every shipyard which can be made available where timber and labor can be secured, of standard wooden vessels with about 3600 tons capacity. It is far easier to obtain carpenters and timber to produce such ships than it is to get the material and skilled labor necessary for steel vessels.

With this situation in the shipbuilding industry it is doubtful how the craft are to be produced to carry on business in the New York barge canal when that is opened a year or so hence. The old Erie canal boats have nearly all disappeared; not more than a couple of hundred are now left, it is estimated. For economical freight handling on the new waterway, vessels will be required of 2000 to 3000 tons' capacity with a beam up to 45 ft. and a draft of not over 11 ft. Such boats will only be suitable for use on protected waters. Where are the men to be found who will invest money in boats of this type to ply on the barge canal in competition with the rail lines when vastly larger returns are promised by building vessels capable of ocean service?

## Engineering Ethics Collated

The ethical considerations underlying or governing the profession of engineering did not assume much importance in the early days. Doubtless the practitioners then were honest and honorable and had certain unformulated moral rules by which they conducted their business, but the definite desire for a Code of Ethics came only as the trade of engineering began to approach a profession in nature. In fact such a desire marks the beginning of the professional spirit.

That such a spirit is strong and healthy today is obvious to the most casual student of engineering progress, but possibly a recent bibliography compiled by the Carnegie Library of Pittsburgh will serve to emphasize the fact. This pamphlet, just issued, is called "Engineering Ethics" and contains 152 references to as many articles in technical and society periodicals on that engrossing subject. To the many individuals and societies now studying the human side of engineering as distinct from the purely technical, this list should be of great service. Thanks are due the library for its recognition of a professional need.

## Fixed Dams To Replace Movable Dams on the Upper Ohio

It is nearly 42 years ago that Congress first authorized the improvement for navigation of the Ohio River. The plan then contemplated the eventual construction of a series of movable dams from Pittsburgh to Cairo, dividing the river at low water into a succession of pools. At flood stages, however, the dams were to be lowered and boats were to use the open river as they did before the improvement.

The first of the movable dams, that at Davis Island, 5½ miles below Pittsburgh, was completed in 1885, ten years after the original appropriation in the River and

Harbor bill of 1875. The dam was at that day considered a great achievement in engineering construction. It was, however, not strictly novel, but merely a copy on a larger scale of what engineers on the continent of Europe had for some time been doing in improving smaller rivers for navigation.

Ever since its completion, the Davis Island dam has served chiefly to create a navigable pool at all seasons of the year in the Allegheny and Monongahela Rivers at Pittsburgh. Congress for many years took only a languid interest in it as the first step in a chain of works that should create slack-water navigation in the Ohio all the way to Cairo. Additional appropriations for locks and dams were made in 1890, 1896, 1899, 1902 and 1905, and two more locks and dams were finally completed in 1904 and 1906, 30 years after Congress made the first appropriations for the work.

A general awakening to the absurd wastefulness of this method of conducting river and harbor work occurred during the Roosevelt and Taft administrations. It came to be realized that the old dilatory methods had saddled the Government with certain works which became obsolete before they were completed, like the Hennepin Canal. It was evident, also, that the slack-water navigation works on inland rivers had in most cases developed no traffic proportionate to the amount expended on the work.

The advocates of waterway improvements claimed, however, that the Ohio was a stream which was big enough and had traffic enough to justify improvement, and that if money were concentrated on the Ohio River work and the depth were increased to 9 ft., instead of the 6 ft. contemplated when the original improvement was planned, a sufficient volume of boat traffic would develop to justify the great investment necessary.

In line with these ideas, Congress in 1910 adopted a project for completing the improvement of the Ohio River in 12 years by the construction of 54 locks and movable dams at a total estimated cost of about $64,000,000, in addition to prior appropriations.

The last annual report shows that in the past seven years about $22,500,000 of that amount has been expended; 16 dams are completed; 18 are under construction, and on 19 others work has not yet been begun. One dam, No. 42, has been eliminated. While the law specified completion within 12 years, Congress has interpreted this to mean supplying the funds in that time, or practically at the rate of $5,000,000 a year, a rate which has been substantially maintained up to the present year. There still remains about $33,000,000 to appropriate to complete the work. Judging by the present and impending condition of the national treasury, it is doubtful whether funds will be forthcoming hereafter to carry out the work at the rate planned.

It is not at all strange that work begun so long ago and so leisurely carried on should in some parts become obsolete before its completion. It is now proposed, and we understand practically decided on, to rebuild one or more of the first six dams below Pittsburgh as fixed dams instead of movable dams. The reasons for this are numerous. Dams Nos. 1 and 2 are in poor condition. The former, now 32 years old, requires constant and extensive repairs and must soon be rebuilt anyway. These dams were originally built for a 6-ft. navigation instead of a 9-ft., and the changes made leave them structurally weaker than the standard type.

A more significant reason, however, is the traffic change which has taken place in the Ohio River. One controlling reason for the original adoption of movable dams for the Ohio River work was the importance of the down-stream coal traffic in large tows when the river was in flood. The coal hoisted from mines along the Monongahela River was delivered into cheap wooden barges and held there until the river rose to a "coal-boat" stage. Then fleets of these barges, often acres in extent, would start down the river steered by a big stern-wheel towboat, and much of it would finally land at New Orleans, where the coal was sold and the barges were broken up for lumber.

This water transportation represented a phenomenally low ton-mile cost; but it was based on conditions which were not permanent. The forests from which came the cheap lumber that built the coal barges have been cut off. It would not pay to tow the empty barges back to up-river points. More important still, the Pittsburgh Coal Co., which controls the bulk of the mines in the Pittsburgh district from which river shipments have been made, has decided that all the remaining coal in the Pittsburgh district will be required for local industries, and hence no more should be sent to distant markets. There are to be no more huge fleets of coal barges started down stream from Pittsburgh when high water comes; hence one of the arguments which 40 years ago caused the adoption of movable dams for the upper Ohio has disappeared. Coal tows are still to be sent down the river, but they will go to the Ohio from some of the rivers which tap the West Virginia coal fields.

The question—and it is a very broad one—is thus raised whether movable dams or fixed dams should be adopted in works for navigation improvement. The United States Engineers have now accumulated a good many years experience in the operation of movable dams. It is realized now, better than in the past, that movable dams of all types are expensive to construct, expensive to maintain and subject to certain risks of accident in operation. Local conditions as to the obstruction of a flood channel by a fixed dam and consequent heavy land damages may make the use of a movable dam necessary at a given point; but the use of movable dams over the whole length of a large river merely to facilitate down-stream navigation during flood season will probably be more critically studied hereafter before adoption.

Besides these questions of engineering practice, the history of the Ohio River improvement is an illustration of the wasteful policy that so long prevailed in waterway legislation of undertaking work without making adequate provision for its vigorous prosecution. There has been a notable change in this respect in the last decade, but there is still need for further improvement. If the Ohio River improvement was worth while 40 years ago, the work ought to have been undertaken then and completed as fast as men and money could do it.

If a private corporation undertakes an enterprise the work is pushed to completion with all possible speed, for interest charges begin to accumulate as soon as the work is started, and it is a race to see whether the profit-earning stage can be reached before the load of interest charges becomes sufficient to swamp the business. Many of those who figure out the profit which Government enterprises yield wholly omit any charge for interest on the money invested during construction.

# Letters to the Editor

## Responsibility of New Pavement Construction in Cleveland

Sir—I beg leave to comment upon the article in "Engineering News," Feb. 17, 1917, headed "Cleveland Engineering Society Urges Commission for City Paving." The inference from reading that article would be that the City of Cleveland possesses no organization to properly design and supervise street paving, as the article states that the supervision of the paving must necessarily be referred to the Street Department, now organized only to care for maintenance work.

As a matter of fact, Cleveland has always had an Engineering Department, under the direction of which the construction and reconstruction of all pavements have been placed. Under the general direction of the writer alone there has been laid some 200 miles of paving at an expenditure of from $7,000,000 to $8,000,000.

In connection with the proposed program of repaving, made possible by reason of the $3,000,000 bond issue to pay for the city's share of paving work, it has been planned, with the exception of a limited amount of resurfacing work, to have the entire amount of such work under the direction of the Engineering Department, as has been the custom in the past.

The suggestion to appoint a commission to assume general direction of paving work is still pending; but in the absence of city-charter changes, which would be necessary to establish a commission of this kind, it is obvious that the mayor cannot shift the responsibility, which he has by virtue of his office, to see that the work is prosecuted in accordance with the method and by the organization now prescribed.

Exception is taken to the statement that "the experience of many cities has demonstrated that the latter plan (special commission) is far more likely to produce honest and economical work." So far as the writer knows, comparatively few cities have appointed commissions to assume direction of paving work, where a proper organization had already been provided through an engineering department.

It is the judgment of the writer that the article might give rise to inferences that neither the sentiment of the Cleveland Engineering Society nor Cleveland's public opinion would justify.

ROBERT HOFFMAN,
Commissioner and Chief Engineer.

Cleveland, Ohio, Feb. 24, 1917.

## The Art of the Dishonest Expert

Sir—The recent contributed articles in "Engineering News" on the subject "The Art of the Expert Witness" were an excellent presentation of a subject which has heretofore received scant attention in the engineering press. It seems to me however that the subject of dishonest testimony by "expert" witnesses has not even yet received the attention which its prevalence demands, and that the dishonest "expert" has been allowed to escape with but a very mild condemnation.

The article in question accounts for a difference of opinion among experts in valuation cases, largely upon the ground of a difference in hypothesis. A difference in hypothesis might be accepted as one of the incidents of independent thought if the hypothesis were plainly set forth, but it is the part of the dishonest "expert" to conceal, and if necessary to deny, his fantastic hypothesis. When it is disclosed upon cross-examination that an estimated value of a water power, for instance, is based upon the utilization of the total unregulated flow of the stream, upon a 100% load factor and upon the sale of the power in a territory already well supplied, then the dishonest "expert" witness cannot escape the judgment of his more honorable associates by pleading a difference in hypothesis. Yet this sort of evidence has become so common that the name "expert witness" has become almost a term of reproach.

The testimony of witnesses is supposed to be for the purpose of enlightening the court upon the facts, so that a just decision may be rendered. If a wholly theoretical hypothesis, having little or no practical application is assumed, the court is confused instead of enlightened, and all expert testimony is to an extent discredited. In a recent book, "Recollections of an Alienist," by Dr. Allan McLane Hamilton, the celebrated authority on brain diseases, a chapter is devoted to the subject of expert testimony; there referring to the prevalence of dishonest expert testimony, Dr. Hamilton says: "The execration of expert testimony by the courts, press and public, is an instance of visiting the sins of the many upon the few—thus reversing the ordinary run of this well-worn saying."

During the last five years there have been tried before the Court of Claims of New York State, water-power damage cases arising from the construction of the new Barge Canal, in which the aggregate damages claimed have no doubt surpassed those ever demanded of any state in the Union as the result of a single project. The trials of these water power cases have called for a large amount of engineering work in their preparation, and have brought forth a mass of "expert" testimony which is a disgrace to the engineering profession. The valuations of water powers by the experts on the two sides in these cases have varied in the ratio of 1 to 10 in many instances, and in the majority of the cases have been so far apart as to create in the nontechnical mind a belief in the utter unreliability of expert testimony. The excuse of difference in hypothesis seems somewhat absurd in cases of such wide variation.

The dishonest "expert" cannot escape just criticism upon the ground that he acts under the direction of the attorney for his clients, for he may resign from the case at the first demand for misleading or dishonest testimony.

It seems to the writer that the only way in which the court may be reasonably sure of securing disinterested and honest technical service is to make the expert witness an appointee of the court, for in that case the expert witness will be as free as the court to render service solely in the interest of justice. The employment of technical assistance by the court need not prevent the employment of expert witnesses by the litigants, but the presence in the case of a competent and disinterested expert would go far to prevent the introduction of dishonest testimony or the use of hypotheses wholly theoretical and without practical application. This plan in effect, has been in operation for several years in the public service commissions of several of the states, where the engineer of the commission takes a part in important cases, assists in clearing up disputed points and is himself subject to cross-examination by either side.

The engineering profession will not be benefited by the assumption that the abuses complained of do not exist. They are already well known to all who have had a part in the trial of cases involving expert testimony, and to a considerable degree by the public at large. The great engineering societies might well devote some thought to a solution of the problem, and the individual engineer should resist every influence tending to restrict his judgment or to force him to work upon a false hypothesis.

H. B. SWEET,
Consulting Engineer.

Utica, N. Y., Mar. 17, 1917.

## More Information on Durax Road Pavement

Sir—In the article entitled "New Jersey Introduces Small Granite Cubes for State Road Paving," in "Engineering News," Mar. 15, 1917, p. 429, a few errors have crept in. In the next to the last paragraph you say: "One portion of the work was not grouted until freezing weather came on; and in order to complete the work, a bituminous mastic was used in place of the portland-cement grout, with apparently as satisfactory results as in the first method." While in my judgment the mastic is equal to the grout as a filler, and has been used on several other jobs, yet no change was made on Morris turnpike.

The costs should be 90c. per sq.yd. for the concrete base and $2.58 a sq.yd. for the Durax paving. The Bamberger & Chapman Co., and not the undersigned, was the contractor, under F. A. Reimer, County Engineer of Essex County, and the Durax blocks were furnished by the Harris Granite Quarries Co., of Salisbury, N. C., through the undersigned.

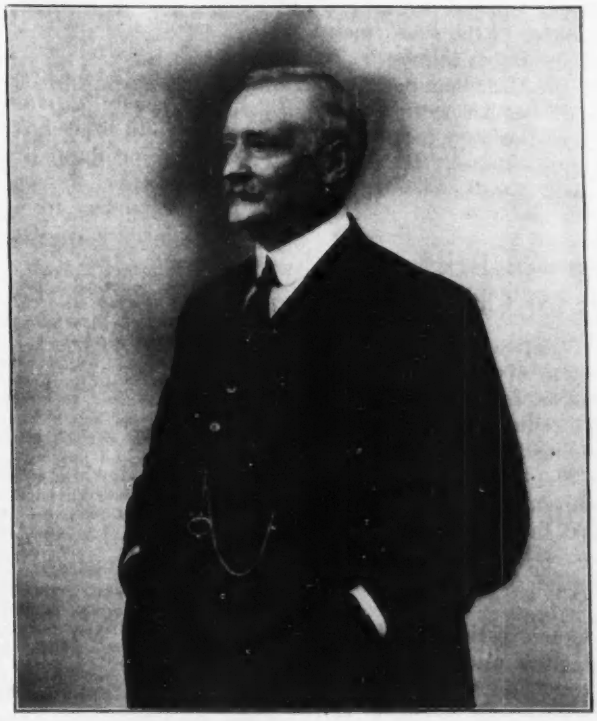
C. E. McDOWELL.

45 Clinton St., Newark, N. J., Mar. 16, 1917.

# Death of George H. Frost, Founder of Engineering News

George Henry Frost, who was the founder and, until 1911, the publisher and chief owner of *Engineering News*, died at his residence in Plainfield, N. J., on Mar. 15 after an illness of several weeks. Although in his 79th year, Mr. Frost had been in good health until a few months ago, when gradual failure of the circulatory system became evident.

Mr. Frost was a Canadian by birth, but his parents were natives of Vermont, who emigrated to St. Lawrence County, New York, and later removed to Canada. Mr. Frost's father established a general foundry business in Smiths Falls, Ontario, which after many years of pioneer hardship was developed by older brothers of Mr. Frost until it became the second largest agricultural implement works in Canada. The early education of George H. Frost was obtained at village schools and later at an academy in Glover, Vt. In the years from 1858 to 1860, he studied civil engineering at McGill University, Montreal. Here he received an excellent training in mathematics and in natural history, taking the latter subject under Principal Dawson, afterward Sir William Dawson. His instruction in civil engineering, however, Mr. Frost described as simply farcical. The modern civil engineering course at McGill was established many years later. At the time of his death Mr. Frost was the oldest living engineer graduate of McGill. According to the custom of that time, Mr. Frost was apprenticed after his graduation to a provincial land surveyor, and after two and a half years' work received a diploma and the right to use the letters P. L. S. after his name and follow the business of a land surveyor. For a few months he attempted to earn a living by surveying land for farmers in the vicinity of his father's home at Smiths Falls, but he soon became disgusted with the dull life and small earnings.



Geo. H. Frost

He had originally taken up civil engineering because it promised a life of roving adventure. In August, 1863, he started on a trip to New York City, but changed his mind on the way and landed in Chicago. He secured employment as a rodman in a railway surveying party which was laying out the line of what is now the Chicago Northwestern R.R., from Madison, Wis., to Winona, Minn. When the season's work closed, Mr. Frost was retained for a year in the office of the engineer, and later for two years in the land commissioner's office.

He then opened an office for himself as a city surveyor. At that time (1867) there were only two or three civil engineering offices in Chicago. About the only profitable work for civil engineers in that locality was simple land surveying, laying out new subdivisions for the rapidly growing city. For a half a dozen years times were prosperous, but in 1873 came the panic and the collapse of a real estate boom, and the land surveying business was at a low ebb.

It was at this time of financial stress that Mr. Frost ventured on a project he had long been considering—the founding of a journal devoted to civil engineering. A more unfavorable time to launch such an enterprise could hardly have been imagined, but Mr. Frost was of an ultrasanguine temperament, and notwithstanding his almost total lack of means he determined to try the experiment. The first number of the *Engineer and Surveyor*, as the journal was called, was issued on Apr. 13, 1874. The matter for the first number Mr. Frost prepared himself in spare time in the evening after his day's work as a surveyor was finished. A relative who was in the printing business attended to the mechanical production of the sheet, and W. F. Goodhue, a civil engineer who was later city engineer of Racine, Wis., attended to the distribution of the printed copies. The journal met a favorable reception and had a bona fide subscription list from the start. It had, however, practically no advertising patronage, and the white paper it was printed on cost in those days 15c. per pound. There was consequently a monthly deficit which Mr. Frost had to make up from his earnings as a land surveyor, eked out by occasional loans. Nearly twenty years ago, Mr. Frost prepared, at the request of the editors, some very interesting reminiscences of these early days in the development of *Engineering News*. In the first issue of the *Engineering News-Record*, to be published on Apr. 5, there will be presented a history of *Engineering News*, prepared largely on the basis of these reminiscences.

From the first, Mr. Frost found it necessary to enlist the aid of others in the editorial conduct of the journal, and the limitation of means and opportunity made editorial changes frequent. In 1878 Mr. Frost removed to New York City, and the journal was thenceforth published there, the offices being located in the Tribune Building for 17 years, and later in the St. Paul Building.

During most of the journal's first decade, the financial returns were meager. In 1883, the late D. McN. Stauffer

joined Mr. Frost in the enterprise, purchasing a part interest in the journal, and assuming editorial direction. Four years later the late Arthur M. Wellington purchased a part interest in the journal, and joined Mr. Stauffer in the editorial work. The years that followed were years of very rapid growth and prosperity. Eventually, Mr. Frost repurchased the interest which had been sold to these and other business associates, and he was the sole owner in 1911, when he finally disposed of the journal to the Hill Publishing Co.

In 1886, Mr. Frost became a resident of Plainfield, N. J., and took an active interest in the public affairs of the city. He served for five years as a member of the City Council, and in the early '90's had the chief responsibility in the establishment of a sewerage system. He purchased the principal paper of Plainfield, the *News-Courier,* many years ago but left the management to his oldest son. He was a member of the Presbyterian Church in Plainfield and took an active interest in its affairs. He was a member of the Canadian Society of Civil Engineers, an Associate of the American Society of Civil Engineers, and was given honorary membership in a number of other engineering societies. He is survived by his widow and four sons.

## Relative Advantages of Brick or Concrete Sewers for Chicago

The relative cost and serviceability of concrete and brick for sewers has been reported upon by the staff of the Chicago Council Committee on Finance, with reference to an ordinance sent to the council by the Board of Local Improvements and providing for a concrete sewer in Kedzie Ave. (south of 71st St.). The report showed no material advantage or disadvantage for concrete as compared with brick, except that the cost for the former probably would be somewhat less. The council committee, however, recommended the use of brick, which is the general practice in Chicago.

The report is based upon local experience and upon inquiry made in a number of cities using concrete for sewers. In Chicago, the trunk and outfall sewers are of brick, with a few exceptions. There are also plain and reinforced-concrete sewers, and the South Chicago district has a system of 2½- to 10½-ft. sewers of plain concrete, built in 1908. The Sanitary District of Chicago permits the use of concrete, brick and segmental block. The element of cost (except in special cases) is the determining factor in selecting the material to be used for its large sewers.

Analysis of the returns for 32 cities using concrete for sewer construction show that 27 are using concrete now and 25 have used it for a number of years. It is not used exclusively by all of these cities. Most of the returns state that there is little or no deterioration or erosion of concrete, though in some cities having steep grades the concrete inverts are lined with vitrified brick to prevent erosion. The grades in Chicago are too light for trouble of this kind.

It is pointed out that under certain conditions the action of acids in or gases from sewage tends to disintegrate concrete masonry and the mortar joints in brick masonry, the extent of the injury in each case depending upon the condition of the sewage. The effect is more noticeable where poor materials and poor workmanship have been used. As Chicago uses the combined system of sewers, the average sewage is greatly diluted and decomposition is not pronounced. There are exceptions, where the sewage is made up largely of trade wastes.

As to cost, the general opinion in a number of cities is that concrete costs 10 to 15% less than brick, the saving being in cost of materials and labor, etc. The report states that advantage is sometimes taken of the effect of the smooth concrete surface in reducing the friction, thereby making it possible to use a smaller sewer of concrete than of brick to carry the same volume of sewage. This means a reduced volume and cost of masonry. As to adaptability, it is stated: "Concrete and brick are equally well adapted to most conditions met in sewer construction, although adherents of one or the other material claim advantages under particular conditions."

The report also quotes the Chief Engineer of the Sanitary District, as follows: "For Chicago conditions, concrete as a material for sewer construction is more suitable than brick, chiefly for the reasons that it is more economical and is fully as good, if not better, from the viewpoint of efficiency and durability."

The advantages of monolithic concrete, concrete pipe and brick for sewers are set forth substantially as stated below. Tile-block construction is not included in the investigation.

**Monolithic concrete is lower in first cost; it may be molded to any form desired; and the thickness may be varied to suit requirements and local conditions. The natural earth under the sewer is not disturbed; and as the concrete fills all irregularities, a better foundation is obtained. With brick and reinforced-concrete pipe proper backfilling under the quarters is difficult to obtain. Reinforced-concrete sewers can be made to develop strength when subject to strains not predetermined. Concrete can be made impervious by proper proportioning, mixing and placing. A smoother surface is obtained in concrete through the elimination of all joints, with a resulting higher carrying capacity.**

**For reinforced-concrete pipe, the advantages are that in wet trenches it may be easily and quickly laid and that proper inspection may be more easily made.**

**For brick, the advantages are that Chicago contractors have reached a high degree of efficiency in brick-sewer construction. Also, under certain conditions, when the progress of work is intermittent on account of traffic or other reasons, or when the job is of limited extent, brick may prove to be more economical.**

Conclusions of the report are as follows:

**The first cost of a concrete sewer is 10 to 15% lower than for a brick sewer. This is based on the opinion of officials in other cities and on data comparable with Chicago conditions.**

**Brick and concrete under typical Chicago conditions are equal in durability for sewer construction. This is based on the experience of other cities in the use of concrete and on the experience with brick in Chicago.**

**Both brick and concrete are adaptable for sewer construction in Chicago.**

**Argument in the New York-Passaic Valley Sewage-Disposal Case** has been set by the United States Supreme Court for Oct. 2, 1917. The suit is for an injunction to prevent the discharge of sewage into New York Harbor from the trunk sewer being built by the Passaic Valley Sewerage Commission from Paterson to Newark, then beneath Newark Bay, Bayonne, and New York Harbor to a multiple outlet near Robin's Reef Lighthouse. The United States was originally a party to the suit, but withdrew on stipulation with the Passaic Valley Sewage District for the treatment of the sewage so as to give an effluent of stated quality. It was supposed that New York City and New York State would also withdraw the suit, but this was not done. Much testimony by many experts has been taken on each side. The case has been pending altogether for years. It was expected that the trunk sewer and tunnel outlet would have been completed and in use before this time, but there has been much delay, owing, it appears, to tunneling difficulties.

# News of the Engineering World

## Interstate Commission Will Study the Port of New York

An interstate commission to study the improvement of railway and water transportation and terminal facilities for the entire port of New York, including the part in New Jersey as well as in New York State, is likely to be appointed through the joint action of Governor Whitman of New York and Governor Edge of New Jersey. It has become more and more apparent during the last decade that the economic development of the port of New York on lines necessary for its future growth and prosperity must be undertaken without regard to state boundaries.

Further than this, it is probable that the development should be carried out with the governing idea of rendering the greatest public service at minimum cost and with all idea of one transportation company taking advantage of another in a competitive way eliminated. Bills are pending in both legislatures to provide appropriations for such a joint commission. Since the movement has the support of both governors, it is probable that the appropriations will be granted.

## Montana Legislature Authorizes Commission-Manager Plan

A well-considered commission-manager plan of government, applicable on approval by popular vote of the cities of Montana, is authorized by a bill that has recently passed the legislature of that state and has been approved by the governor. The legislative functions of cities adopting the new form of charter will be performed by three commissioners at large in cities of less than 25,000, and by five commissioners in those of 25,000 population or more. Each commissioner must own real estate in the city, assessed at a value of not less than $1000. The salary of each commissioner will be $5 for each meeting attended, with 50% additional for the commissioner who serves as mayor. The commissioners are subject to recall, but it is interesting and encouraging to note that a recall provision applying to the city manager was stricken out of the bill. The city manager will be appointed by the commission. He need not be a resident. He will hold office at the pleasure of the commission. His salary will be fixed by the commission, but will not be subject to decrease during his term of office.

The duties of the city manager will be to see that all laws and ordinances are enforced and to appoint all directors of departments and all subordinate employees in the departments, both for classified and unclassified service, the latter subject to civil service. The city manager will have power of removal also. He will formulate the budget for submission to the commission.

City affairs will be administered under five departments, each headed by a director, subject to the orders of the city manager. The five departments are service, welfare, safety and finance. The commission *may* appoint a Municipal Plan Board, and upon the request of the city manager it *shall* appoint advisory boards. The Civil Service Commission will consist of three electors appointed by the city commission or council. The act went into effect on its approval by the governor.

The director of public service is given authority "to compel the making of sewer, water, gas and other connections whenever, in view of contemplated street improvements or of sanitary regulation," such connections should in his judgment be made.

The director of public service is also made supervisor of plats, with authority to "require all streets and alleys to be of proper width, to be co-terminate with the adjoining streets and alleys." Plats made on his initiative or made by property owners on their initiative are subject to his approval. No other streets or alleys except those approved by the supervisor of plats or those "laid out by the municipality" shall be "accepted as public streets or alleys by the municipality." Another significant feature of the commission-manager charter act is this: "No plat subdividing lines within the corporate limit, or within three miles thereof, shall be entitled to record in the recorder's office of the county without the written approval of the director of public service indorsed thereon."

## An Appeal for Assistance to British Engineers and Professional Workers

Few engineers in the United States probably realize the serious hardship which the civil engineers, architects and members of other professions in Great Britain have suffered since the outbreak of the war. The mechanical engineers, indeed, have had work in plenty; but engineers in most other lines have been almost wholly without employment. The following appeal to the engineers of America on behalf of the engineers and other professional workers of Great Britain has been issued over the signatures of eighty prominent American engineers.

**To the Members of the Engineering Profession in the United States:**

**The families of many professional men in Great Britain are experiencing privation such as they have never before been called upon to face. This is true not only as regards families of those at the front, but also as regards families of many who are excused from active service because of age or physical disability, but who find themselves in need owing to the fact that they no longer are able to earn an income in the practice of their professions. For example, an architect in England today has practically no possibility of professional employment, except in governmental work, as the construction of buildings, except those required for Government purposes or specifically authorized by the Government, is not permitted.**

**To relieve the resulting hardships and distress, the Professional Classes War Relief Council, Inc., was organized in Great Britain shortly after the outbreak of the war. Maj. Leonard Darwin, a son of the great naturalist, is chairman of the Council. Jerrard Grant Allen is now in America representing the Council, and independent investigation has confirmed his statements in respect not only of the need which exists, but also in respect of the organization and methods of the War Relief Council.**

The administrative expense, which is limited to compensation of subordinate employees, amounts to less than 2% of the money distributed. The Council directs its activities largely along lines which provide relief by finding temporary employment for those whose accustomed way of earning a living is cut off, but in many cases pecuniary help is necessary.

The undersigned appeal to American engineers to demonstrate their sympathy by contributing to this most worthy object. Let us help in this crisis as we should hope our professional brethren in Great Britain would help us were their position and ours reversed.

Contributions may be forwarded to Lewis B. Stillwell, treasurer, care the Farmers Loan and Trust Co., 475 Fifth Ave., New York.

Alden, G. I., Worcester.
Arnold, Bion J., Chicago.
Baekeland, Leo H., Yonkers.
Brackenridge, W. A., Los Angeles.
Buck, Harold W., New York.
Byllesby, H. M., Chicago.
Carty, John J., New York.
Crosby, Oliver, St. Paul.
Doherty, H. L., New York.
Dunn, Gano, New York.
Duryea, Edwin, Jr., San Francisco.
Emmet, W. L. R., Schenectady.
Galloway, John D., San Francisco.
Gibbs, George, New York.
Herr, E. M., Pittsburgh.
Herschel, Clemens, New York.
Hollis, Ira N., Worcester.
Humphreys, A. C., New York.
Hunt, Charles Warren, New York.
Insley, W. H., Indianapolis.
Insull, Samuel, Chicago.
Jackson, Dugald C., Boston.
Jennings, Hennen, Washington
Lincoln, Paul M., Pittsburgh.
McHenry, E. H., New Haven.
Mailloux, C. O., New York.
Mershon, Ralph D., New York.
Molitor, F. A., New York.
Parsons, William Barclay, New York.
Pegram, George H., New York.
Rand, Charles F., New York.
Rice, Calvin W., New York.
Rushmore, D. B., Schenectady.
Sanderson, E. N., New York.
Saunders, William L., New York.
Sprague, Frank J., New York.
Stillwell, Lewis B., New York.
Swain, George F., Cambridge.
Taylor, Stevenson, New York.
Thomas, C. C., Baltimore.
Townley, Calvert, New York.
White, J. G., New York.
Wilgus, W. J., New York.
Yarnall, D. Robert, Philadelphia.
Yeatman, Pope, New York.
Younger, John, Buffalo.
And thirty others.

## Cleveland Street Paving Discussed

The street paving situation in Cleveland was the subject of the annual meeting of the Civic League of Cleveland on March 17. It was announced that the League will spend between $7000 and $8000 during the year on paving inspection and that about $6000 is now in hand. The league will employ a competent paving engineer who will hire his inspectors. Daily reports will be made to the secretary of the League and weekly or monthly reports will be made by the League to the public. Primarily the effort is to recite facts to the public and to prevent the acceptance of paving which is in any way below specifications. It is the intention, also, in this recitation of facts to give praise where due.

C. S. Howe, president of the Case School of Applied Science, speaking on "The Need of a Comprehensive Plan of Paving," stated that the $3,000,000 paving bond issue involved the expenditure on the part of the whole city of from $6,000,000 to $30,000,000, depending on whether the bond issue was used mostly to relay or to pave streets new. On new work the city's share is 10%, on relay 50%, according to present plans, the abutting owner paying the rest. It is the largest sum Cleveland has ever determined at one time to spend. Probably not more than a million a year will be spent so that the work authorized by the bond issue will extend over several administrations. He argued that a definite plan of procedure should be drawn up by a competent committee or board, and that the plan should be turned into law by the council so that succeeding administrations could not alter it; in other words, he would give it stability and freedom from politics. He argued for a competent paving engineer under the city engineer, and that the paving engineer should not change with the administrations as the city engineer may.

Alex. Bernstein, Director of Public Service, spoke on "The Administration's Plan and Point of View." He said that a survey of Cleveland pavements had been made in 1916 and a paving program mapped out by the Engineering Department. It was found that the most pressing need is the repaving of the main thoroughfares, 42 miles needing immediate repaving. He paid a high tribute to Robert Hoffmann as the best equipped man for mapping out such a program, he having been in the department 23 years. He also paid high tribute to Mr. Williams, Mr. Hoffmann's assistant in charge of paving. Mr. Bernstein said all inspectors were to be appointed from the civil service list.

Robert Hoffmann, speaking on "The Engineering Problems Involved," said that it is comparatively easy to find engineers expert in one line of pavement, but not in all. He noted that manufacturers employ engineers expert in their particular line of pavement and that the experience and knowledge of these men are available. Touching on the financial features, he said the city ought to look forward to the end of the life of the pavement and make proper provision for renewal. If the average life of a pavement is 25 years, then the program should provide for the renewal of over 20 miles annually, Cleveland having 570 miles of paved streets.

## Hetch Hetchy Water-Supply Progress and Program, San Francisco

Considerable progress on its great water-supply scheme was made by San Francisco in 1916; and if recommendations made by M. M. O'Shaughnessy, city engineer, are carried out, much more will be done and some important contracts will be let this year.

During 1916 over 80% of the Hetch Hetchy R.R., which is 68 miles long, standard gage, was graded and 9 miles of track laid. This road extends from Hetch Hetchy Junction, on the Sierra Ry., to the site of the Hetch Hetchy dam and will be used for construction purposes. Progress was also made on a temporary power plant at Early Intake. This is known as the Lower Cherry power development and will supply power for construction purposes. At the Hetch Hetchy dam site a 20-ft. diversion tunnel, 457 ft. long, begun in 1915, was completed. A large area of the future reservoir has been cleared. Detailed surveys show that the total length of the aqueduct from the Oakdale portal in the Sierra foothills to the University Mound reservoir will be 118.66 miles or 2 miles more than was given in the Freeman preliminary report.

On Jan. 5, 1917, a contract for exploring the Hetch Hetchy dam site was let to the International Diamond Drill Contracting Co. for an estimated total of $14,675. The borings must be completed within 120 days. The plans and specifications for the dam will be drawn as soon as these site borings are completed. It is hoped that a contract for the construction of the dam will be let during 1917.

Bids for constructing 19 miles of aqueduct tunnel from Early Intake to Priest regulating reservoir, near Moccasin Creek power house, will probably be invited this year. The estimated cost of this section is $6,000,000. It is proposed to divide it into several four-contract units of

about 5 miles each, and that 4 or 5 years will be required for the work.

A bond issue of $11,000,000 was recommended by Mr. O'Shaughnessy some weeks ago, of which $10,000,000 would be for the Hetch Hetchy dam and 19 miles of aqueduct, and $500,000 for the temporary power development, each as already mentioned, and the remaining $500,000 for numerous minor purposes. The dam and aqueduct appropriation would be expended during a series of years, but the money must be provided before the contracts can be let.

## Relation of State Boards of Health to Water-Supplies Discussed

Whether a State Board of Health should have compulsory or advisory powers was the most important subject of discussion at the annual meeting of the Illinois section of the American Water-Works Association, held at the University of Illinois on Mar. 13-14. The former view was taken by Paul Hansen, engineer of the Illinois State Board of Health, on the ground that it is necessary to have control over the actions of local authorities. S. A. Greeley (Winnetka) supported this view, pointing out that advice from the Board has failed to induce the local authorities of Winnetka to install a filtration plant, which is much needed on account of typhoid cases in towns further north. On the other hand, John W. Alvord (Chicago) considered that the main action of such boards should be on educational and advisory lines, and that their usefulness will be destroyed if they assume arbitrary control, as has been the experience in other states. W. A. Shaw, of the State Public Utilities Commission, suggested control of pollution of all navigable streams by the Federal Government.

## Looking for a Nitrate-Plant Site

Hearings on the question of the location of the Government nitrate plant, for which $20,000,000 has been appropriated, were held at various Southern cities beginning March 8 by the interdepartmental board, consisting of the Secretaries of War, Interior and Agriculture. Accompanying them on their tour of investigation were Gen. W. M. Black, Chief of Engineers, United States Army; Col. C. B. Wheeler, of the Army Ordnance Department; G. O. Smith, Director of the Geological Survey; Col. C. Keller and Capt. C. L. Sturdevant of the Army Engineers; O. C. Merrill, Engineer of the Forestry Service; C. L. Parsons, Chief Chemist of the Bureau of Mines, and J. N. Carothers, of the Bureau of Soils.

Columbia, S. C., was the first city visited; Gadsden E. Shand spoke on behalf of the Broad and Saluda Rivers. At Augusta, Ga., W. H. Burr presented the engineering advantages of the development of the Savannah River, where two developments, 20 miles apart, would provide 92,000 hp. At Atlanta, Ga., hearings were held on the Chattahoochee and the Coosa River, advocated separately. B. M. Hall discussed the engineering features of the former, where 100,000 hp. is available; C. G. Adsit, engineer for the Georgia Railway and Power Co., described the hydro-electric advantages of the Coosa. At Birmingham, W. G. Walde, of Nashville, presented the claims for Muscle Shoals, where 680,000 hp. can be obtained, it was stated. A steam plant at Tuscaloosa, Ala., in combination with water-power at the locks on the Warrior River was the suggestion at the Tuscaloosa hearing. At Nashville, it developed that the City of Nashville favored Muscle Shoals, but representatives of towns on the upper Cumberland River argued in favor of that district and said that 75,000 kw. could be developed. At Louisville, Ky., the board heard argument in favor of the use of the falls of the Ohio River, by which 50,000-hp. could be developed for ten months a year, with supplementary steam power. At Wheeling, W. Va., the construction of a steam plant was urged.

The board will next visit Western sites and following this trip will be able to report to the president. At the same time, reports of the American Academy of Sciences on the question of processes will be presented.

## Three-Fourths of Second Simplon Tunnel Completed

In spite of constant labor difficulties during the past two years the second Simplon tunnel has progressed to over 75% completion. The report for January, 1917, shows that of the total length of 19,825 m. there has been driven 15,597 m. of top heading (the bottom heading was driven as pioneer heading at the time the first tunnel was built), and only 140 m. less of full excavation was made.

The masonry lining has been completed on a length of 15,058 m., or 76% of the final length; of this about 8000 m. is in the south end and 7000 m. in the north end. The working force is now slightly under 1000.

## Poor Sewers Worse Than None

That the inadequacy of sanitary sewers in certain sections of Birmingham, Ala., has developed conditions worse than those prevailing in districts without sewers is the declaration contained in a formal statement issued by J. D. Truss, Commissioner of Public Works and a civil engineer. The absence of storm sewers to carry off the rainfall causes the sanitary sewers to become flooded in heavy rainfall and the sewage to overflow in basements and streets. One section unprovided with sewers failed to report a single case of typhoid fever during an epidemic last summer, while an important residential section, which was sewered, had the largest amount of typhoid. Commissioner Truss said: "From my observation I think an inadequate sewer system is worse than no sewer at all. Birmingham's system is inadequate and should be considered a disease spreader instead of a filth carrier." He urges that storm sewers be built, beginning at the lower edge of the drainage area.

## Bascule Bridge Drops on Steamer

The south leaf of the Broadway bascule bridge over the Milwaukee River at Milwaukee, Wis., dropped about 3 a.m., Mar. 14, striking the pilot house and bridge of steamer "No. 3" of the Pere Marquette Line. The damage done is estimated at $2000 to $4000 for the steamer, but only about $100 for the bridge. Witnesses state that this leaf was raised for the steamer and then lowered just before it entered the draw; it was raised a second time and then lowered again, striking on the pilot house. As the boat's bridge was torn away, it caught the whistle

cord and signaled the engineer for full speed ahead; and at the same time the wheel was also caught, turning the rudder so that the boat swerved to one side and ran into the dock before it could be stopped. This was very fortunate, as had the rudder not been turned, the boat would probably have gone into the Chicago & Northwestern Ry. bridge a few hundred feet below, before the engineer could have been notified to stop the engines. The only personal injury was to one of the boat's crew, who was slightly cut by flying glass.

Because of the fact that a new center lock was being put on the bascule and also because some changes were being made in the electrical equipment, it was at first feared that something had gone wrong with the machinery. Consequently, the Field Superintendent of Bridges (of the city's Department of Public Works) immediately called the Bridge Electrician, and they both arrived at the scene about 3:45 a.m. A careful examination convinced them that everything about the structure was in first-class working condition. They then operated the bridge several times, with results that substantiated their conclusions. The bridge tender seemed to be at a loss as to just what had happened, but thought the brakes were not working. These, however, were found to be in perfect adjustment and held the bridge in any position desired. This was to be expected, as they had been adjusted but a few days previous to the accident.

As the brakes were in perfect working order at 4 a.m., it hardly seems reasonable that they were in poor order at 3 a.m.; and the two possible explanations of the accident were that the bridge was raised and again forced down by the wind before the bridge tender could set the brakes, or that for some reason or other the bridge tender failed to set the brakes. The first of these seems hardly tenable, as the wind velocity was not exceptionally high (about 15 miles per hour) and that the leaf was twice raised and lowered. It is thought hardly possible that an experienced bridge tender (as this one was) would let his bridge get away from him twice within a few seconds, if he were in full control of his faculties. It seems evident, therefore, that for some reason or other the brakes were not properly handled.

The bridge is of the trunnion type, a double-leaf plate-girder deck span 128 ft. c. to c. of trunnions. Keyed to the trunnions are sector racks gearing with operating pinions. It was described and illustrated in *Engineering News*, July 14, 1904. For information as to the accident we are indebted to J. C. Pinney, Superintendent of Bridges and Public Buildings, Department of Public Works, Milwaukee, Wisconsin.

**A Commission-Manager Charter** for Kingsport, Tenn., has been enacted by the legislature. The city has grown from 200 to 8000 population within a few years, it is said.

**A State Flood Commission for Kansas** has been provided in a bill just signed by Governor Capper. It provides for the appointment by the governor of two commissioners, who, together with the governor, constitute the commission. The two appointive members of the board are to be civil engineers. They are to serve without salary, but are allowed actual expenses. State employees may be appointed. The duties of the commission are to investigate the problems arising from floods, and to look after the domestic water-supply, drainage, water power and supply for irrigation purposes. Drainage districts already created are not in any way under the supervision of this commission.

**Extension of the Chicago Drainage Canal** for two miles at Joliet to a new 24,000-hp. hydro-electric plant on the Des Plaines River is proposed, in order to provide power for operating pumping stations of the Chicago water-works. The sustained opposition of the City of Joliet and of private concerns proposing water-power projects has been overcome, the city being assured of ample protection against floods and overflow. It is estimated that the extension and power plant will cost about $6,600,000 and that the work can be completed in three years. It is necessary to wait, however, for the passage of a bill by the Illinois legislature authorizing the Sanitary District of Chicago to build the extension, dam and power plant. This bill has been prepared.

**Prevention of Further Floods at Chattanooga, Tenn.,** is being studied following a flood which reached a stage of 47.7 ft., 30 ft. above flood stage, on Mar. 7. The damage to factories, houses, roads, etc., is estimated at $1,000,000. Consideration is being given to the construction of a levee system and the Southern Ry. has directed R. W. Jones, Resident Engineer, to make surveys to estimate the cost of levees for protection against a 54-ft. stage. The Chattanooga-Hamilton County Flood Prevention Association was formed at the same time by local business organizations and will ask the legislature to authorize a vote on a $500,000 bond issue for flood prevention. Three levees are planned to protect lowlands along the river, with floodgates to protect Citico and Chattanooga Creeks, the backwater of which causes considerable damage at high stages of the river. One or more pumping stations to take care of flooded low areas are planned. Congress is to be asked to appropriate $1,000,000, under the plan for flood-prevention work on the Mississippi and Sacramento Rivers, by which the Federal Government gives twice the amount provided by local interests. Sanitary work in the flooded district has been placed under the direction of G. W. Knight, a sanitary engineer, of Chattanooga, and a volunteer committee. The measures taken include the requirement that every house must be thoroughly cleaned and lime used liberally before being occupied; pouring oil in wells along the river used as water-supplies; and disinfecting of all sources of contamination. In adddition, many houses considered unsanitary have been condemned.

## PERSONALS

**Sydney O. Swenson,** M. Am. Inst. E. E., has left the engineering staff of Putnam A. Bates, New York City.

**J. C. Halsema, H. C. Buckland** and **E. D. Fitchner** have organized a contracting company in Jacksonville, Fla.

**M. B. Myers,** formerly Assistant to the Vice-President of the American Manganese Steel Co., has been appointed Sales Manager, with headquarters in Chicago.

**P. D. Van Vliet** has been appointed Publicity Manager of the Universal Portland Cement Co., Chicago. Mr. Van Vliet has been connected with the department some years.

**C. C. Jones,** formerly in the engineering department of the Chicago, Milwaukee & St. Paul Ry., has become senior member of Jones & Bohmke, engineers and contractors, Hutchinson, Kan.

**E. B. Goode,** for four years Metropolitan District Sales Manager for the Lehigh Portland Cement Co., has been appointed Sales Manager of the Hercules Cement Corporation, with offices at 30 East 42nd St., New York City.

**John C. Hiteshew,** formerly City Engineer of Carlisle, Penn., has been appointed Borough Engineer and Commissioner of Streets for Waynesboro, Penn., to succeed George C. Brehm, who resigned several weeks ago to take up similar work in Massachusetts.

**M. D. Gates,** formerly Chief Engineer of the Boyne City, Gaylord & Alpena R.R., has resigned to form a partnership with C. E. De Leuw, former Assistant Engineer for Ewing & Allen, Chicago. The firm of Gates & De Leuw will have offices in the Monadnock Block, Chicago, and will specialize in municipal and drainage engineering.

**C. A. F. Flagler,** Lieutenant-Colonel, Corps of Engineers, U. S. A., in charge of the Washington (D. C.) Engineering district, has been designated Military Attaché at Rome, succeeding Maj. Elvid Heiberg, who was accidentally killed by a fall from his horse on the Italian front. No one has been appointed to succeed Colonel Flagler as yet.

**C. S. Cook,** Manager of the Railway and Lighting Department of the Westinghouse Electric and Manufacturing Co., has been appointed General Manager of the Duquesne Light Co., succeeding the late Robert S. Orr. Mr. Cook was born in Massachusetts, was graduated from the Worcester Polytechnic Institute in 1887, and was employed by the Westinghouse company in that same year.

**Julian C. Smith,** Fel. Am. Inst. E. E., M. Can. Soc. C. E., M. British Inst. E. E., was recently awarded the Gzowski medal of the Canadian Society of Civil Engineers for his paper on the Cedars Rapids Power Development. He was born in Elmira, N. Y., in 1878, completed the mechanical engineering course at Cornell University, and is now General Manager of the Shawinigan Water and Power Co. He was chief engineer of the Cedars project during its design and construction.

**E. M. Durham, Jr.,** who has recently been appointed Assistant Chief Engineer of Construction of the Southern Railway, was general agent of the executive department for the road and its subsidiaries, with headquarters at Chattanooga, Tenn. He graduated from Lehigh University in 1896 and entered the service of the Southern Railway in 1900 as assistant engineer at Selma, Ala. He was made assistant chief engineer in charge of construction in the Mississippi delta in 1906 and in 1914 he became special engineer of valuation of the Atlanta, Birmingham & Atlantic R.R. His appointment as general agent at Chattanooga was made on Nov. 1, 1915. He will remain at Chattanooga for several months, in charge of construction in the Middle South.

## OBITUARY

**J. J. von Weyrauch,** of the faculty of the Stuttgart Technische Hochschule for 41 years until his retirement in 1915, died at Stuttgart, Germany, on Feb. 13, 1917. He had reached the age of 71.

**Willard Wendel White,** civil engineer, at one time with the Boston & Maine R.R., and later in private practice, died recently in Boston. He was born in Natick in 1848, graduated from Sheffield Scientific School, Yale, in 1869, and for the past nine years had resided in Wellesley Hills. He was a member of the Boston Society of Civil Engineers.

**George Christoph Mehrtens,** prominent for many years as an expert in bridge construction, died at the age of 73 on Jan. 10, 1917, at his home in Dresden, Germany. For many years he was professor of structures at the Dresden Technische Hochschule. He entered the editorial field some years ago with the journal "Der Eisenbau," in whose publication he was one of the leaders.

**Ferdinand W. Roebling,** Treasurer and General Manager of the John A. Roebling's Sons Co., Trenton, died at his home in that city on Mar. 16, following a month's illness. He was born in Saxonburg, Penn., in 1842. He is the son of John A. Roebling, the pioneer wire-rope manufacturer in this country. Following graduation from the Polytechnic College, Philadelphia, he specialized in chemistry. John A. Roebling began the manufacture of wire rope at Saxonburg in 1840, transferring his plant to Trenton in 1848. Ferdinand Roebling was a member of the local Engineers' Club.

**Reuben Miller,** prominent in the steel industry, died on Mar. 5 in Pittsburgh, at the age of 76. He was born in Pittsburgh and became an apprentice in the works of Robinson, Miner & Miller, designers and builders of Clinton furnaces, later becoming mechanical engineer at the Black Diamond works of Park Bros. & Co. Later he became a partner in Miller, Barr & Parker, which concern 10 years later took the name of Miller, Metcalfe & Parker, eventually being merged with the Crescent Steel Co. He then became Chairman of the Board of Directors of the Crucible Steel Co., and retired from active business in 1914.

**John F. Alden,** M. Am. Soc. C. E., a former Director of the American Bridge Co., died at his residence in Rochester, Feb. 27, at the age of 65 years. He was graduated at the Rensselaer Polytechnic Institute, in the class of 1872, and was for years a builder of steel bridges, especially for railroads. He organized and was proprietor of the Rochester Bridge and Iron Works, which he sold to the American Bridge Co., in 1901. He was a member of the Rochester Society of Engineers, at one time a Vice-President of the American Society of Civil Engineers, a Director of the Traders' National Bank of Rochester and the Genesee Valley Trust Co., and President of the Locke Insulator Co.

**Oscar G. Murray,** Chairman of the Board of Directors of the Baltimore & Ohio R.R., died in Baltimore, Md., on Mar 14, at the age of 69 years. He was born in Bridgeport, Conn., and after an extensive railway experience became Vice President in charge of traffic of the Baltimore & Ohio R.R. in 1896, and in the same year was named by the United States Court as a co-receiver with the late John K. Cowen. In 1900 the receivers were discharged and the property was reorganized, Mr. Murray continuing in charge of the traffic department until 1903, when he was elected president of the railway, succeeding L. F. Loree. In 1910 he was succeeded by Daniel Willard, the present President.

**Maj. Cassius E. Gillette,** a retired officer of the Corps of Engineers, U. S. A., died at his home in Philadelphia on Mar. 18, aged 58 years. In 1897 Major Gillette was placed in charge of the United States Engineer Office at Savannah, Ga., succeeding Capt. Oberlin M. Carter, who had been stationed at Savannah for an unusually long time and had during that time conspired with Gaynor & Greene, contractors engaged on river and harbor work in the district, to defraud the Government of between $2,000,000 and $3,000,000. Carter was one of the most popular officers in the service and was strongly intrenched socially and politically. One member of the contracting firm was a retired Captain of Engineers and another was Chairman of the New York State Democratic Committee. Major Gillette was a comparatively unknown man, without means or influence. Carter's social standing was such that when Major Gillette, after assuming charge of the Savannah office and making investigations, presented a report to the Chief of Engineers accusing Carter of defrauding the Government, Gillette was ostracized in Savannah society, and many officers of the Corps of Engineers refused to believe in the possibility of Carter's guilt. A board of engineer-officers was appointed to investigate the charges, and on their report Carter was court-martialed. At the conclusion of the longest trial ever held by the United States Army, he was convicted and sentenced to imprisonment at Fort Leavenworth. Following that the contractors were also convicted and sentenced; and at the end of court proceedings, which lasted more than a dozen years, the Government recovered a considerable amount of the funds which Carter had obtained as a result of the fraud. The result of these trials was due more than anything else to the ability with which Major Gillette presented the Government's case. A number of years later, serious frauds were discovered in connection with the contracts for the Philadelphia water-filtration plant, and a reform administration in Philadelphia appealed to the War Department for assistance in reorganizing the Water Department on a business basis. President Roosevelt agreed to give Major Gillette a leave of absence from the Corps to undertake the work for the City of Philadelphia. Political influences in Congress attempted to prevent this by the passage of legislation to prevent such work by an engineer-officer, and to meet this situation Major Gillette resigned from the Corps. He was in charge of the Philadelphia Water Department during the completion of the filtration work, and when the reform administration which had employed him got out of power he opened an office for the practice of consulting engineering. He was chief engineer for a Philadelphia syndicate which undertook large mining and land development enterprises in Mexico, which were very prosperous until interfered with by the Mexican revolution. Major Gillette is survived by his widow, one son who graduated from West Point and is a Lieutenant in the regular army, and two daughters.

## ENGINEERING SOCIETIES

ILLINOIS GAS ASSOCIATION.
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago.

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting. Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago.

ST. LOUIS RAILWAY CLUB.
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

**Illinois Section American Water-Works Association**—At the annual meeting held at the University of Illinois, Mar. 13-14, officers were chosen as follows: Chairman, Emmett MacDonald, Lincoln, Ill.; vice chairman, W. W. DeBerard, Chicago; secretary, Dr. Edward Bartow, Urbana, Ill.

**American Institute of Electrical Engineers**—E. W. Rice, Schenectady, N. Y., has been nominated for president at the meeting of the Board of Directors held in Chicago on Mar. 9. The other nominations are: For vice presidents, Frederick Bedell, John H. Finney, A. S. McAllister; for treasurer, George A. Hamilton.

**Vermont Society of Engineers**—The annual meeting of the Vermont Society of Engineers was held in Burlington, Mar. 14. A feature of the three sessions were the reports of standing technical committees on public policy, roads and pavements, power development, mechanical and electrical science, railroads and structural engineering, sanitation and public health, and natural resources. The individual members of these committees presented brief papers on various aspects of these subjects as encountered in the state. The following new officers were elected: President, Prof. A. E. Winslow, Norwich University, Northfield; vice president, C. F. Purinton, Leader Evaporator Co., Burlington; secretary-treasurer, G. A. Reed, City Engineer, Montpelier. The last-named office is a consolidation.

## Appliances and Materials

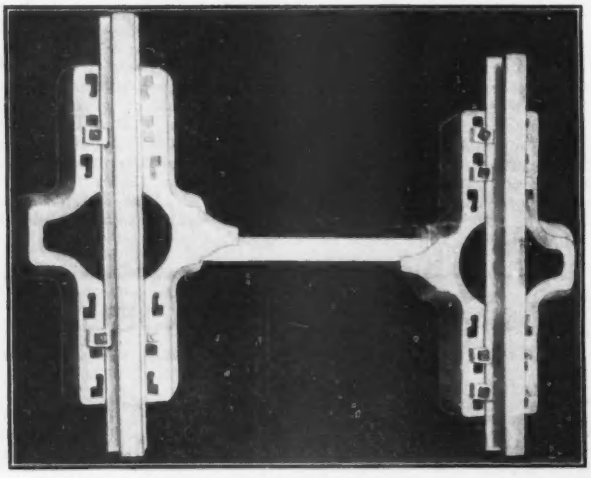
### New Zinc, Tin and Lead Coatings

A method of securing a protecting coat of zinc, tin or lead alloys on steel or copper products, new to this country, is being promoted by Henry Hess & Son, of Philadelphia. The various materials entering this process carry the trade name "Epicassit" and have been used for some time in Germany. Metal powder is mixed with a liquid vehicle and applied with a brush. Then the supporting metal to be coated is heated to the melting point of the tin, lead or zinc. Where possible the heat is to be applied on an uncoated side, but objects may be heated over a fire or in a clean flame. Grease, rust, burnt coatings, etc., must be removed. The following coatings are available: "A," pure tin; "B," $\frac{3}{5}$ tin and $\frac{2}{5}$ lead; "C," $\frac{1}{3}$ tin and $\frac{2}{3}$ lead; "CN," 5% tin and 95% lead; "E," 35% tin with 15% lead and 50% zinc. The latter is a substitute for "galvanizing."

* * *

### New Cast-Steel Tie

The metal tie shown in the accompanying view is composed of two cast-steel blocks connected by a tie-bar. The blocks are about 46 x 22 in. and 5 in. deep, laid with the longer dimension parallel with the rail. Slotted holes hold the heads of bolts to which the rail clips and nuts are fitted. The weight of the tie complete is about 200 lb. Some of the ties have been



SILVER'S CAST-STEEL TIE

laid experimentally on an industrial spur. This tie is the invention of Joseph A. Silver, 854 West 181st St., New York, and is being handled by the Silver Steel Tie Co., Merchants Bank, Salt Lake City, Utah.

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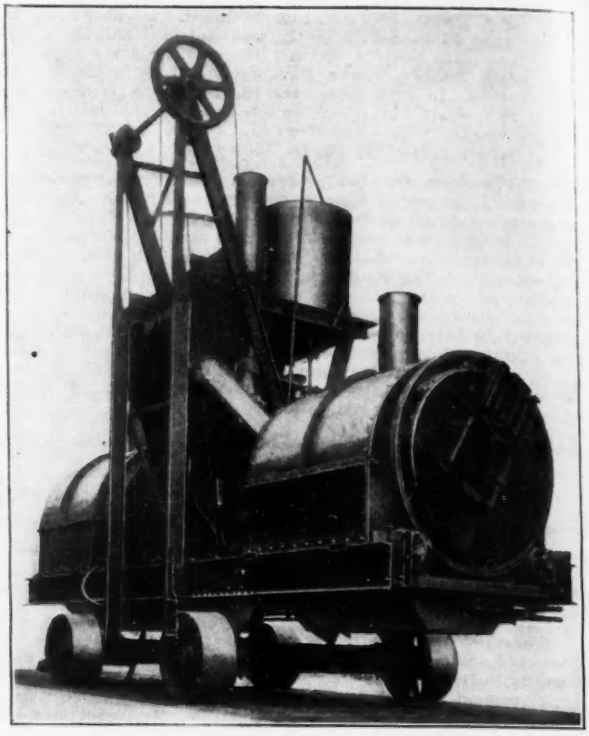
### Asphalt-Mastic Mixing Machine

The Iroquois Works of the Barber Asphalt Paving Co., Buffalo, N. Y., has placed on the market an asphalt-mastic mixing machine designed to replace the usual pot method of melting prepared mastic cakes, by combining the necessary ingredients at the site of the work. The machine consists of two rotating mixing drums driven through gears by a steam engine. The boiler is mounted between the drums and is designed to use oil fuel. A skip and elevator are provided for hoisting the materials to an elevation where they will run into the drums, which are heated by oil burners under them.

The mixing drums are cylindrical, each resting on four wheels or rollers, which engage with rails on the drum. The



DOUBLE-DRUM ASPHALT-MASTIC MIXING MACHINE

drums are provided on the interior with flights so arranged as thoroughly to mix the ingredients. The heads of the drums have openings for receiving the materials and for discharging the heated mastic. Either drum may be rotated independently of the other, the intention being to fill and empty them alternately. The drums are surrounded by housings that contain the oil-fired furnaces. The whole machine is mounted on four steel wheels. It is 18 ft. long over all and 7 ft. 3 in. wide over the wheels. The width over the skip is 10 ft. The shipping height is 10 ft. 7 in. and the operating height 16 ft. The whole machine weighs about 8½ tons.

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### Power Unit for Section Cars

For converting a hand-car into a power-operated section car a kerosene-engine unit has been devised. This, with all accessories, is mounted on a frame about 6 x 2 ft., which can be fitted to the car in very short time. The 5-hp. engine has a single, horizontal air-cooled 4 x 4-in. cylinder and two 16-in. 55-lb. flywheels. A belt runs over a 4½-in. pulley on the engine shaft and a 14-in. pulley fitted to one of the car axles. The engine starts on gasoline (for a few strokes only), and it is stated that the machine can run 35 to 40 miles on a

HAND-CAR CONVERTED INTO A SECTION MOTOR CAR

gallon of kerosene. The car has a maximum speed of 15 miles per hour and can haul a supply car, as shown in the accompanying view. The outfit weighs about 415 lb., with batteries, 1¼-gal. fuel tank and all equipment. It is known as the "Sheffield Power-Top" and is being introduced by Fairbanks, Morse & Co., of Chicago.